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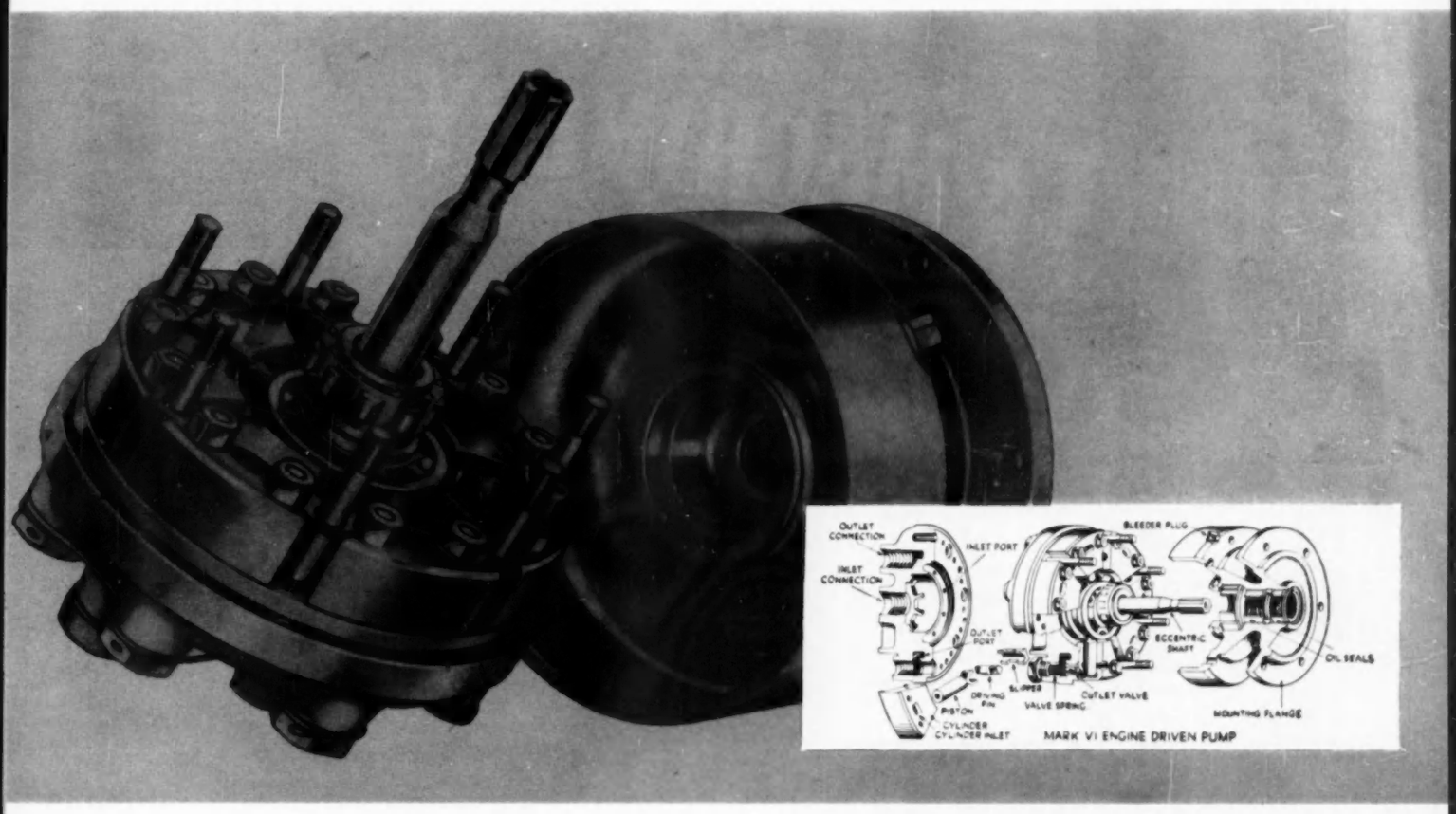

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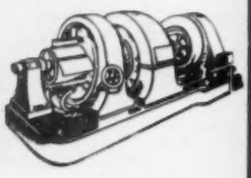
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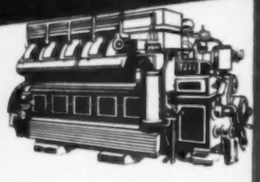
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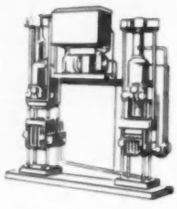
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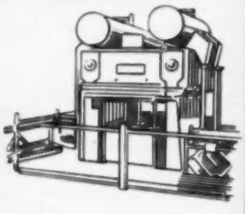
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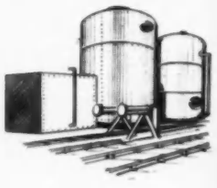
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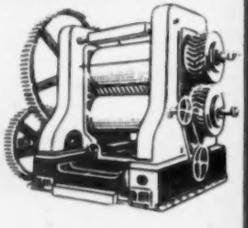
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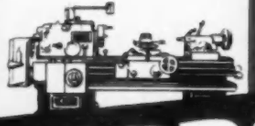
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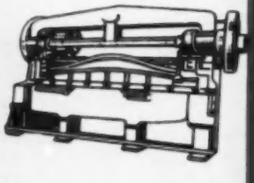
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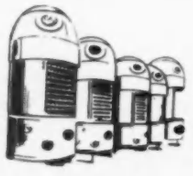
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THE ENGINEER

Established 1856

No. 5465 **OCTOBER 21, 1960** VOL. 210

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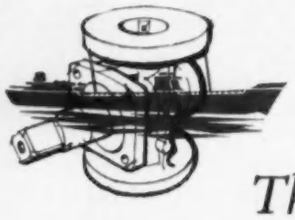

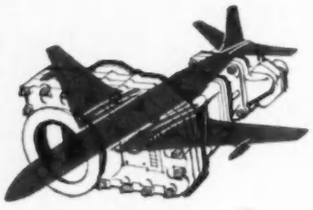

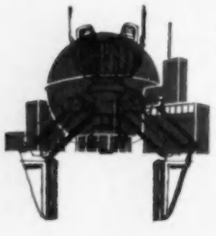

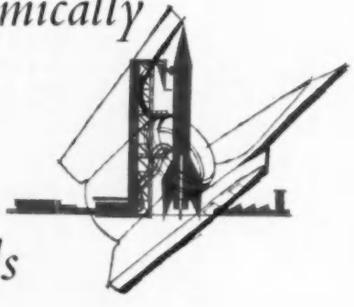

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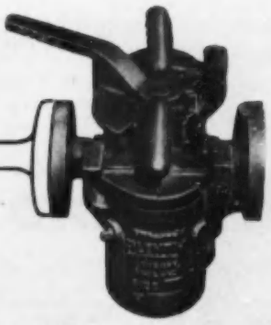

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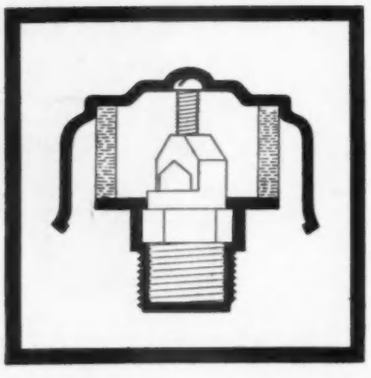

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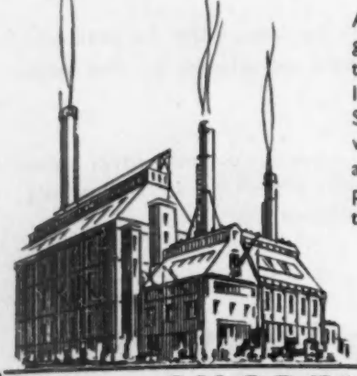

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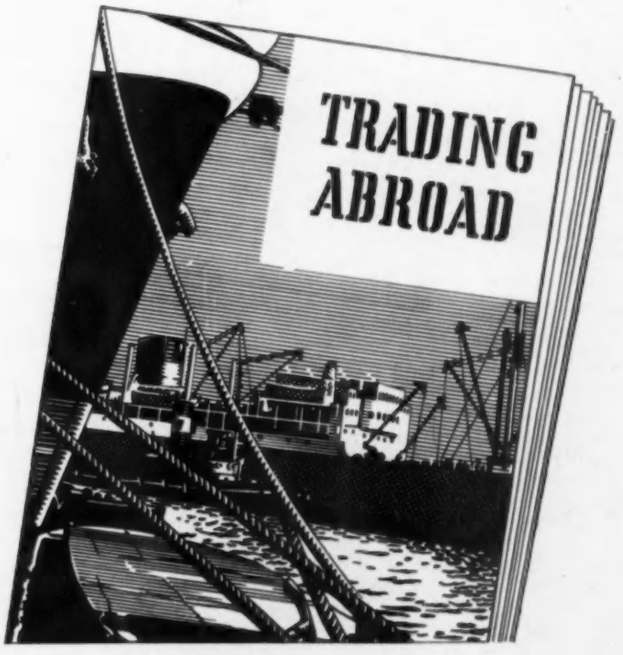

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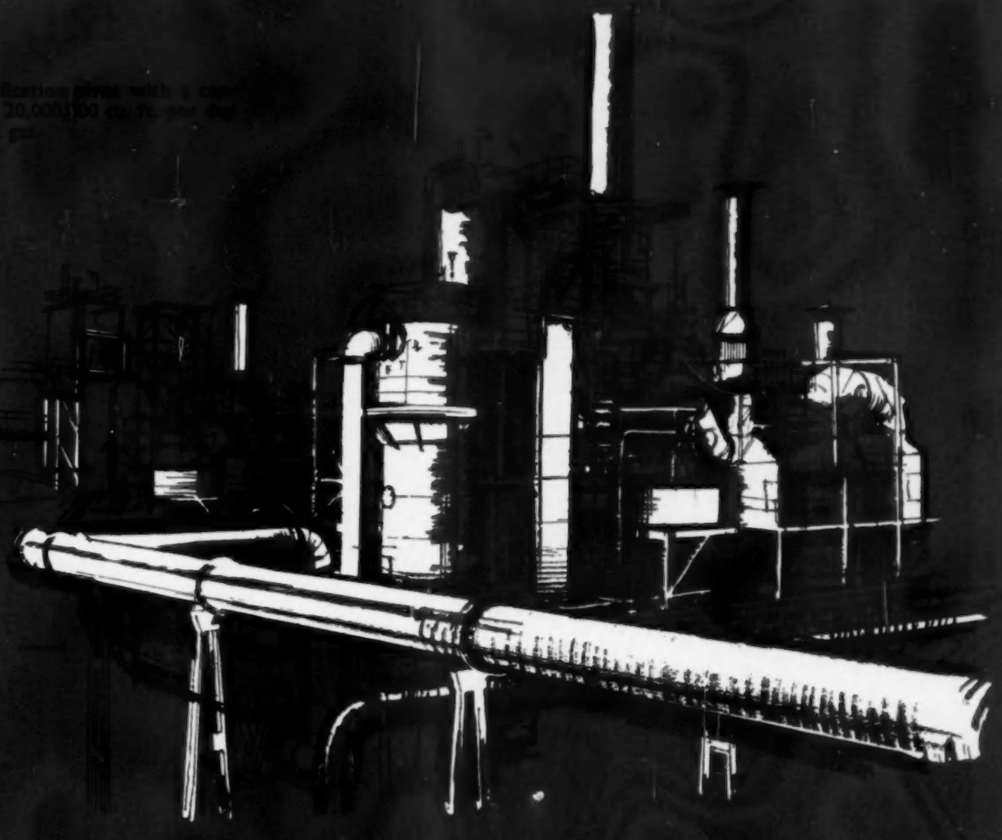

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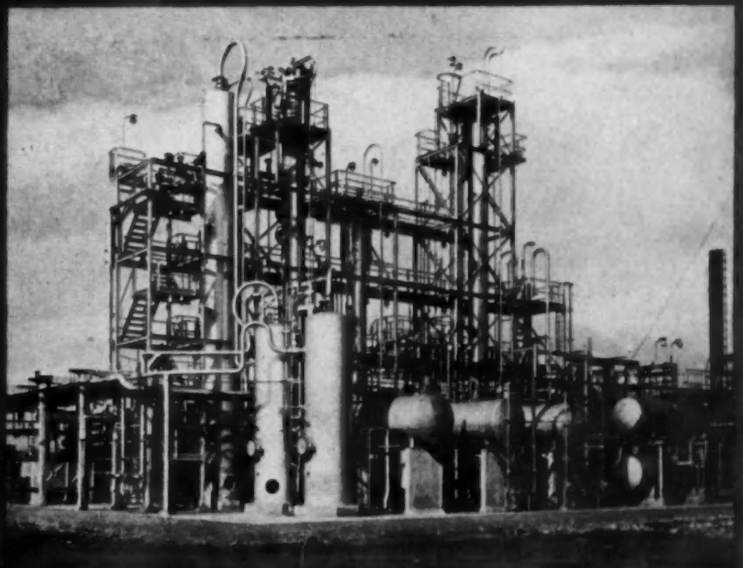

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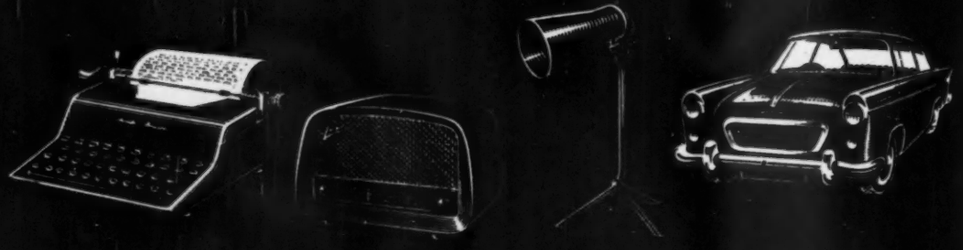

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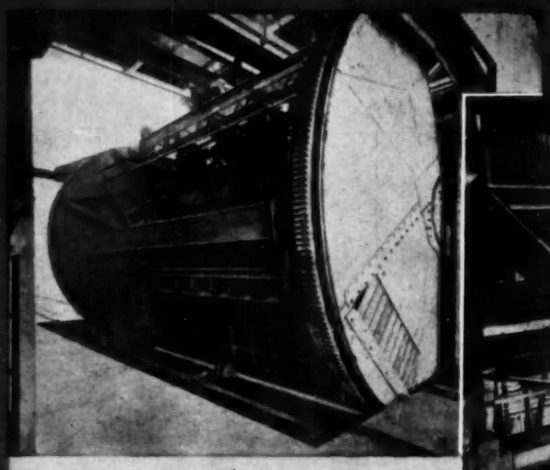
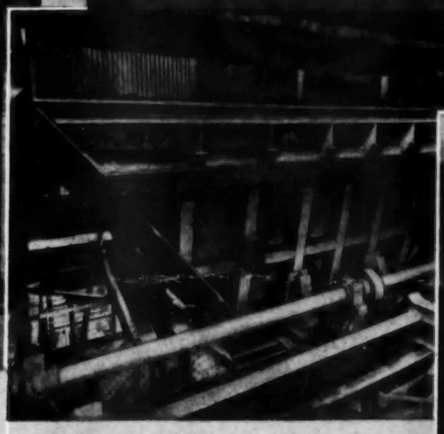


Ore is tipped out of the truck here . . .



falls into this hopper . . .

mounted on 6 Metalastik mountings.

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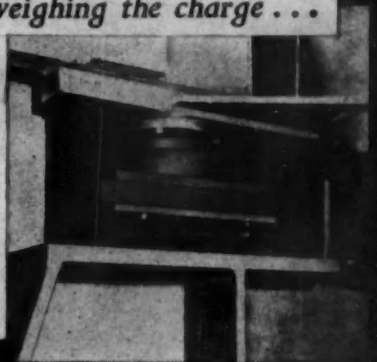
At the Stanton Ironworks, ore is discharged from railway wagons by means of a tippler and crashes into a hopper. Normally 25-35 tons may be discharged in 30 seconds, sometimes in a steady stream but occasionally lumps of iron ore, exceeding 3½ tons fall 10-ft., resulting in impact loads which are considerable and could be damaging. Furthermore the vibration and shock impulses—unless checked—would be transmitted to adjacent buildings and plant. Accordingly the suppliers of the plant, Mitchell Engineering Ltd. called in Metalastik to reduce the harmful effects by providing mountings which normally support 11 tons each, deflecting 0.1". Under the extreme conditions already mentioned the deflection is 0.3", making a very considerable reduction in the shock effect. A similar problem arose at Samuel Fox's works in Sheffield where a magnet crane discharges large masses of scrap metal into a 60-ton scale transfer car from a considerable height. The loadcells employed had to be safeguarded from excessive shock loads in order to maintain their high accuracy indefinitely. Davy and United Instruments Limited, who engineered the loadcell weighing equipment into the installation, met the problem by incorporating Metalastik mountings as illustrated in the accompanying pictures. Whether for a small instrument, a diesel engine or a great piece of industrial plant, Metalastik mountings can always improve the conditions.

On this transfer car for weighing the charge . . .



. . . the 'loadcell' is protected by Metalastik mountings.

METALASTIK

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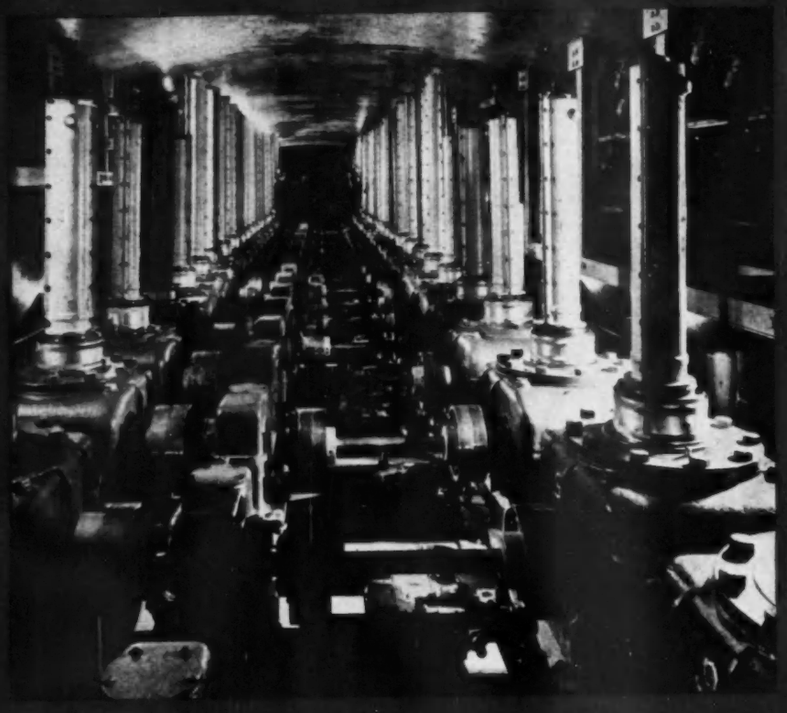
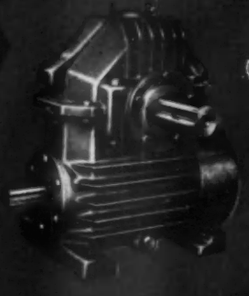


AND SMALL JOBS



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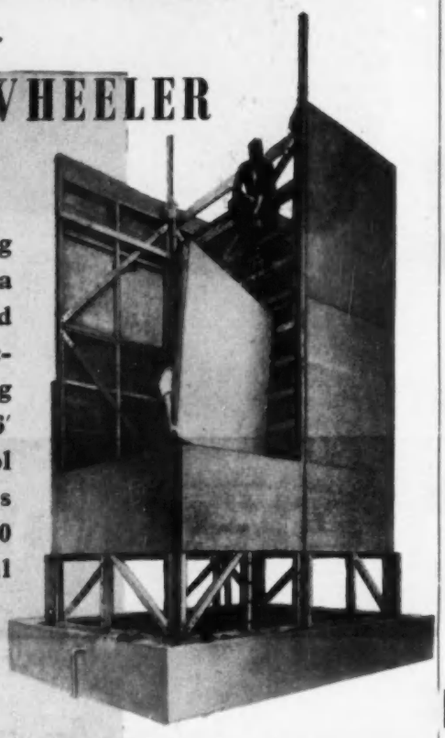

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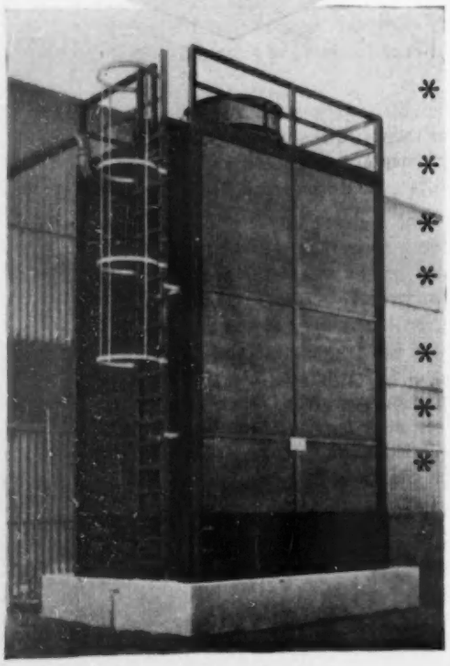

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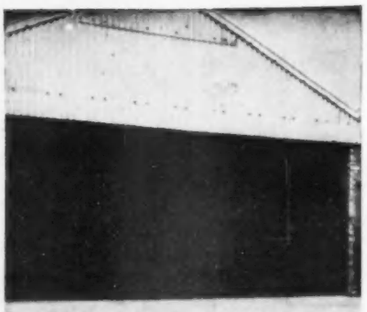
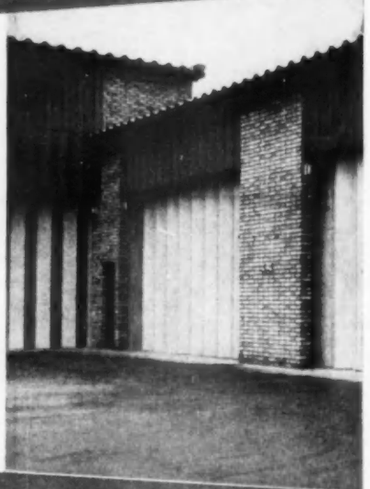
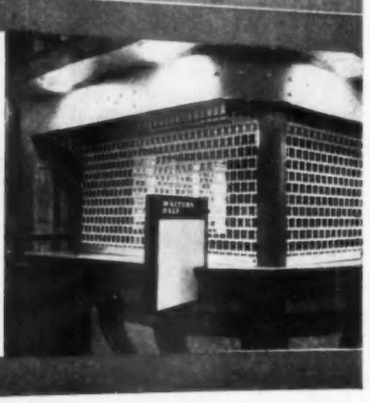


sliding shutter doors



rolling grilles



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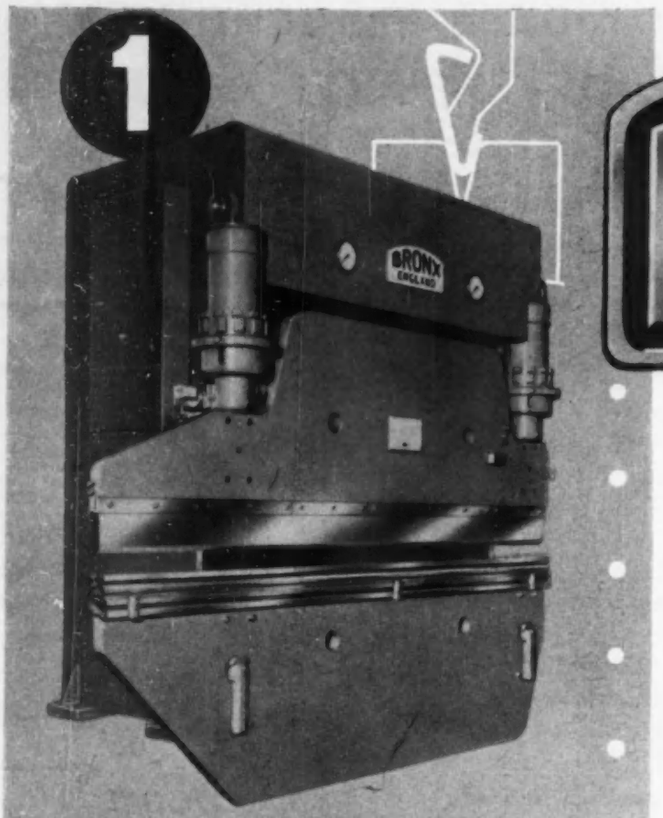

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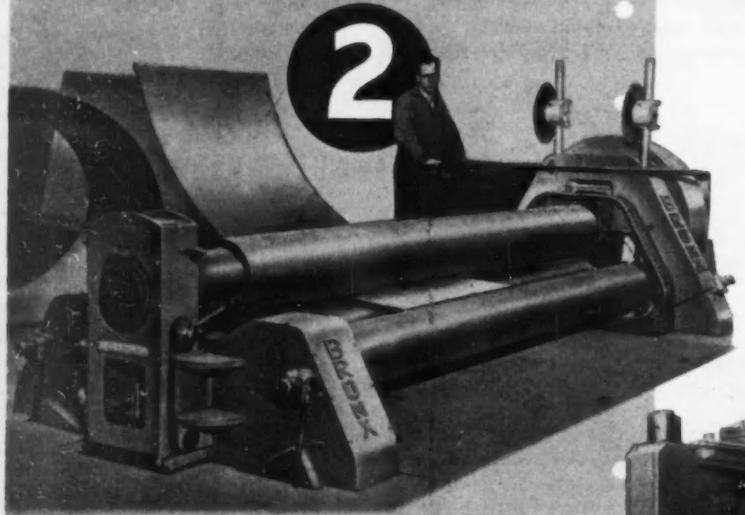

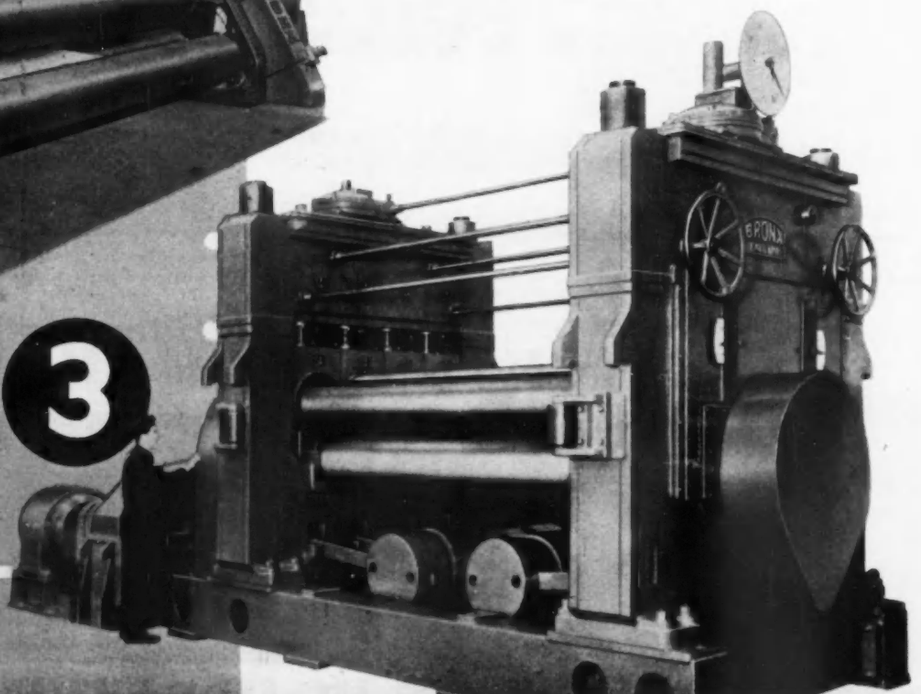

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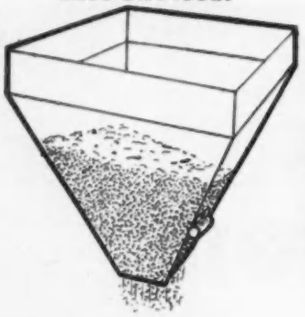
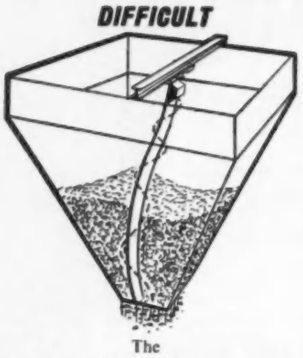


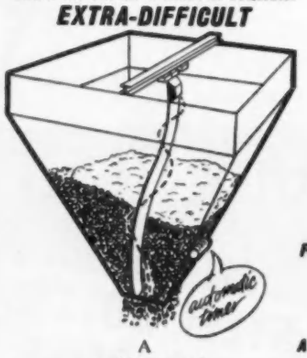
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

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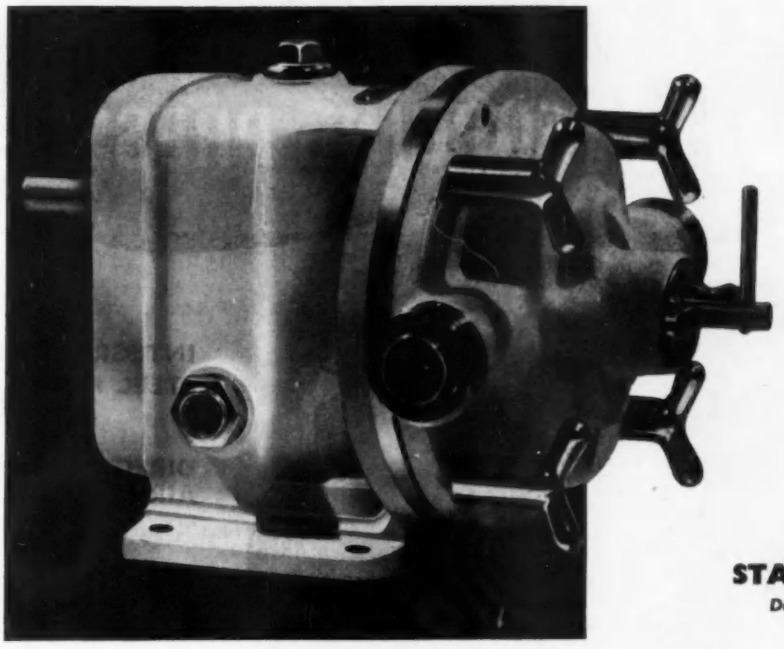

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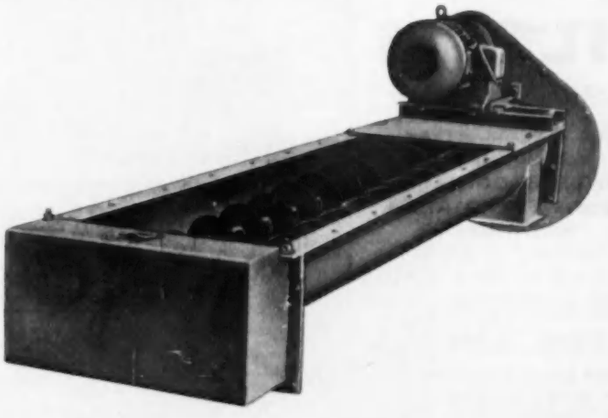

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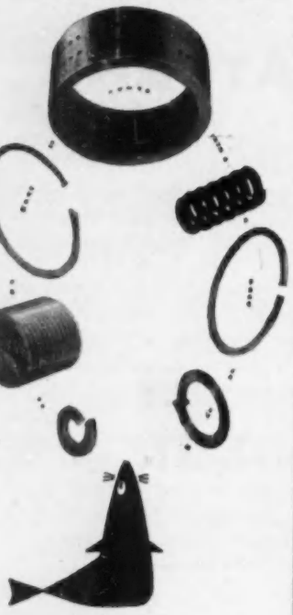

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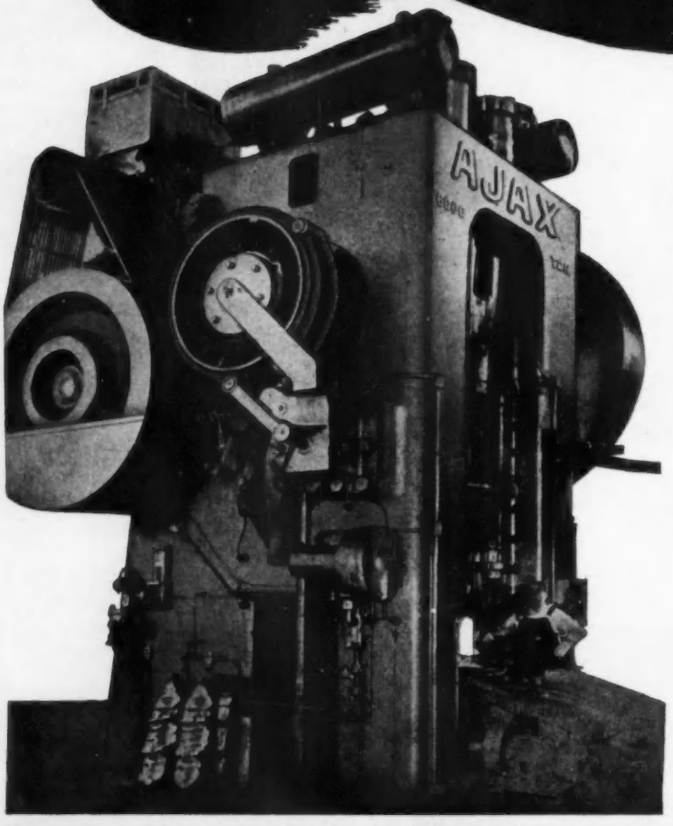

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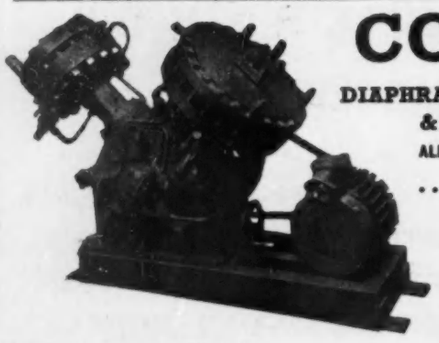

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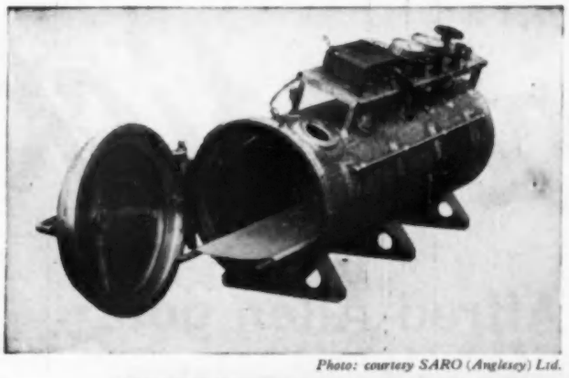

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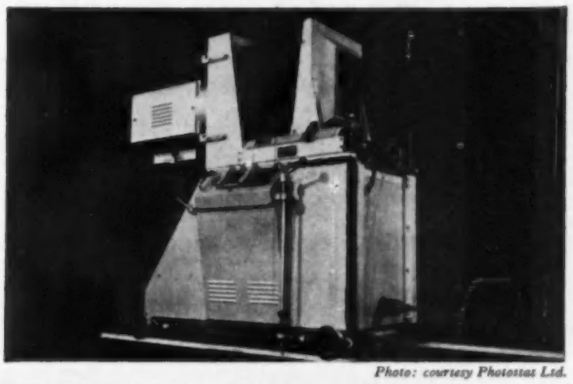

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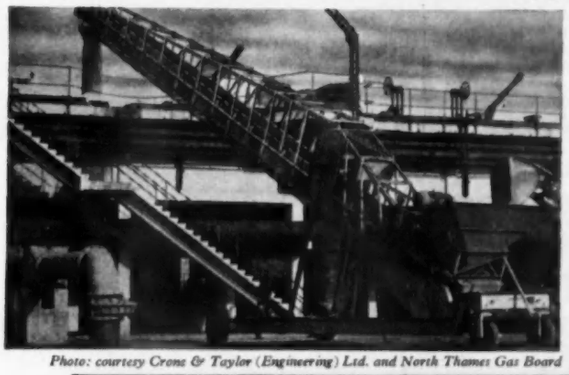

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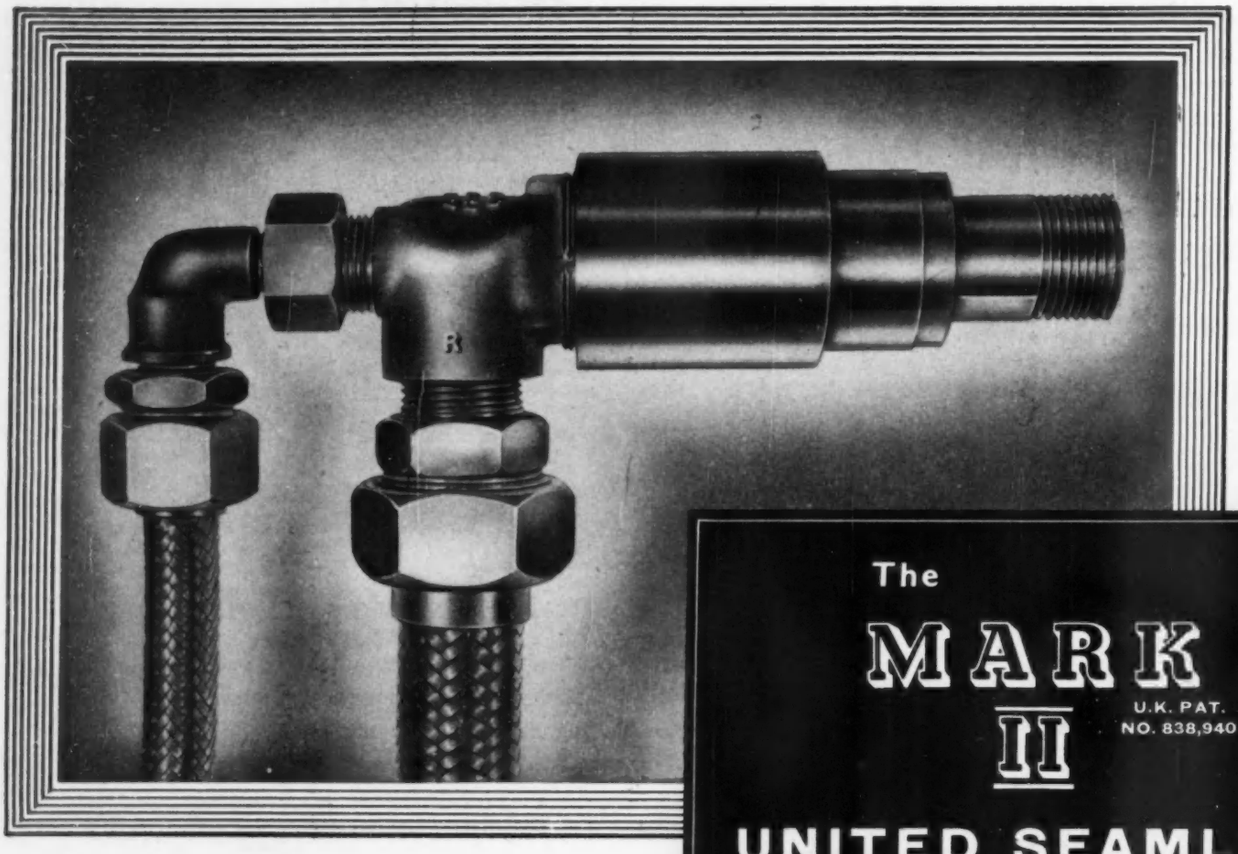

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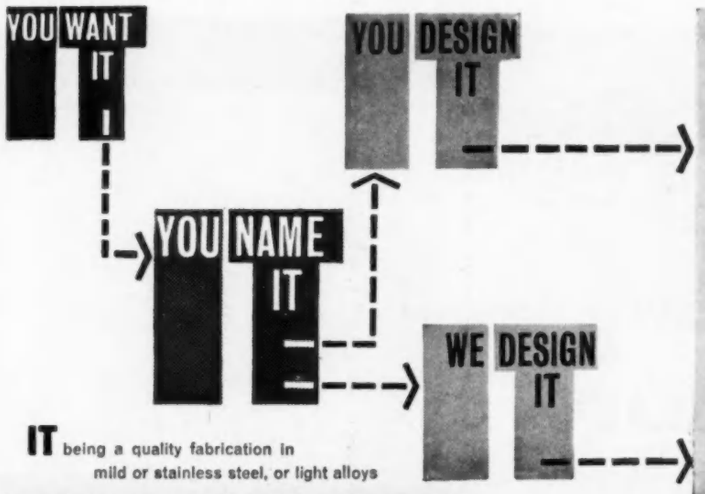
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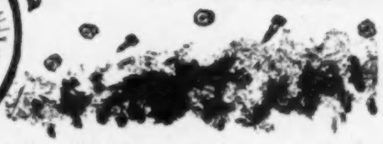

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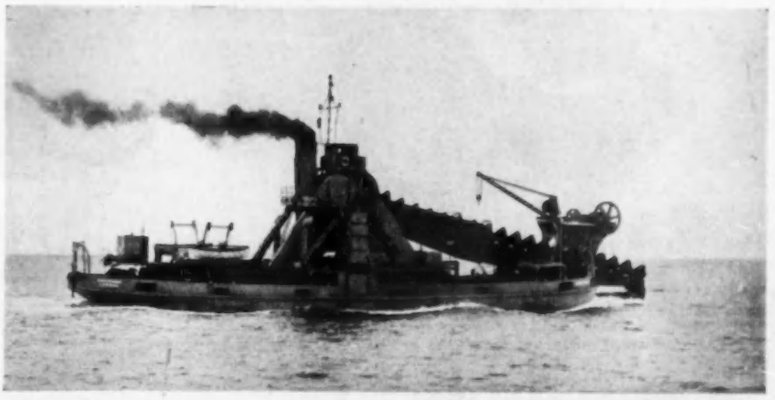

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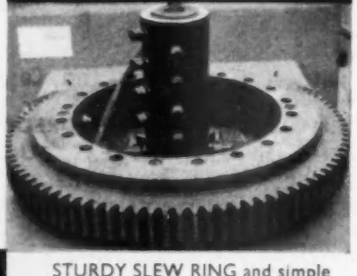

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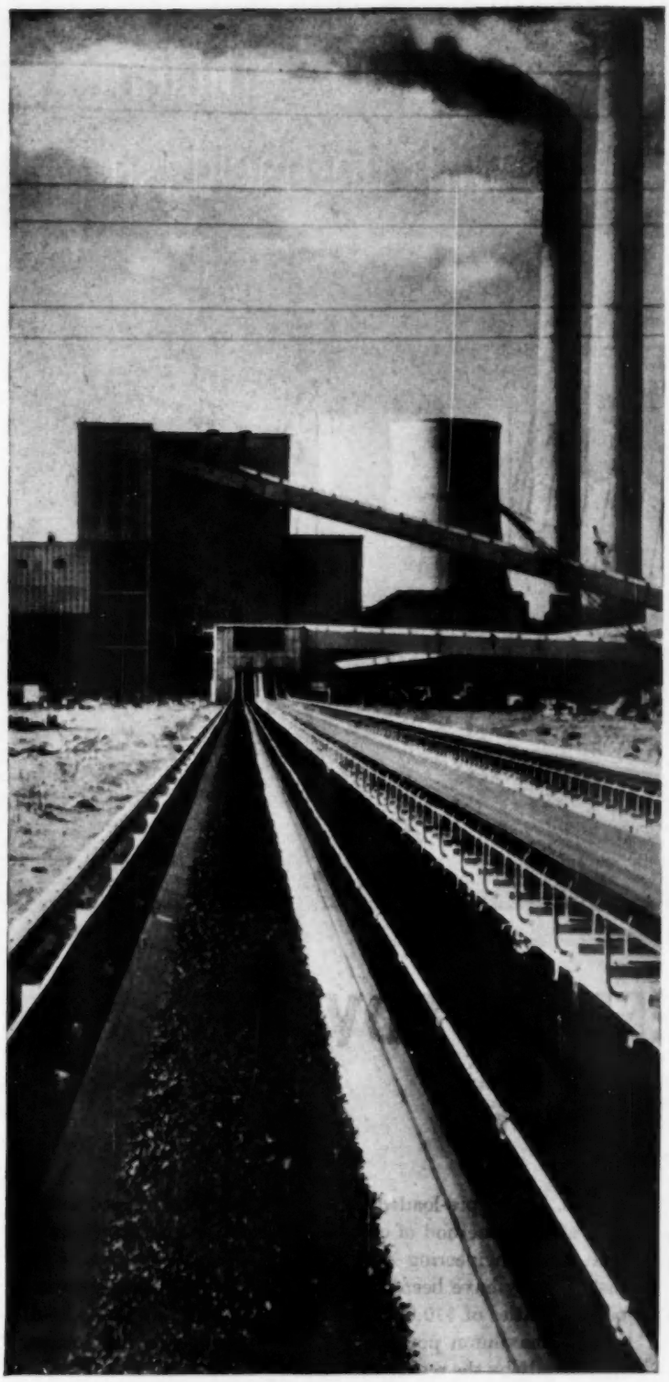

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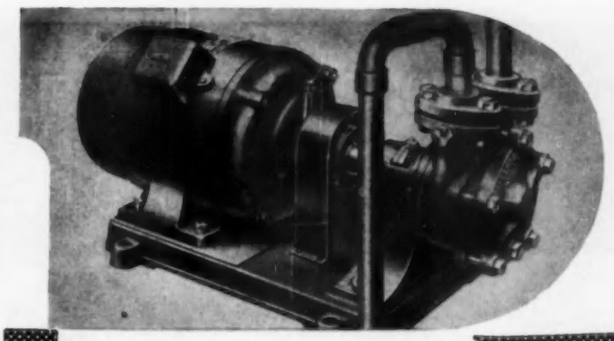

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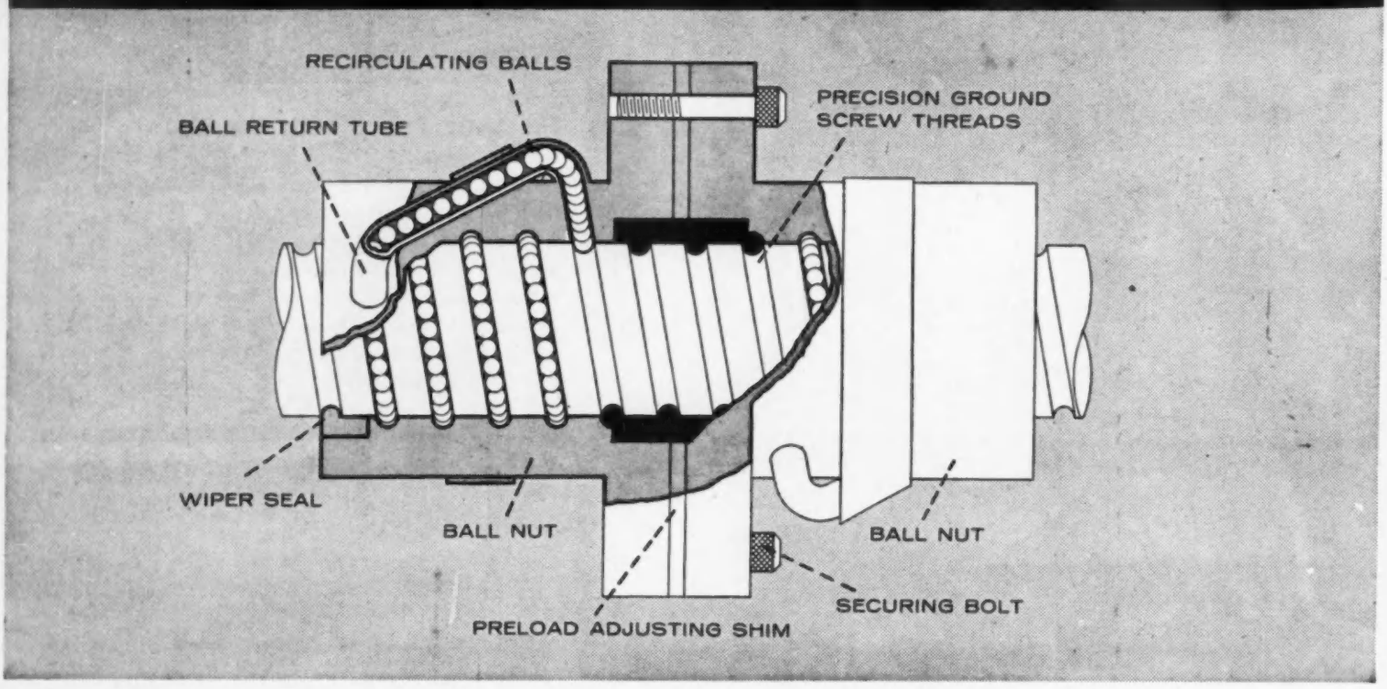

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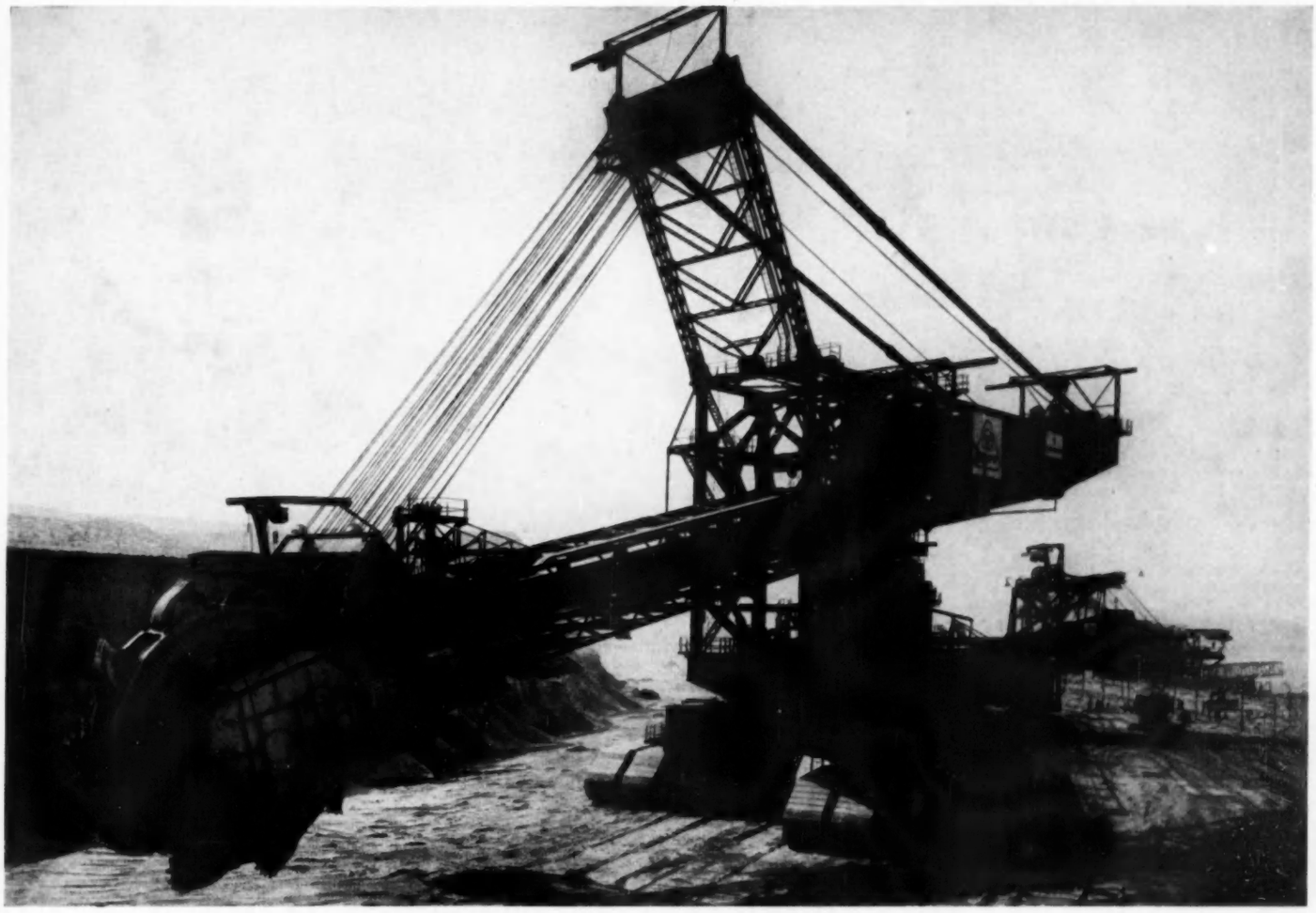

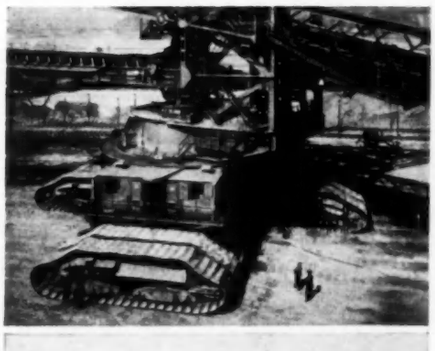

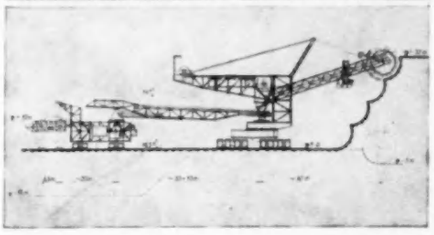

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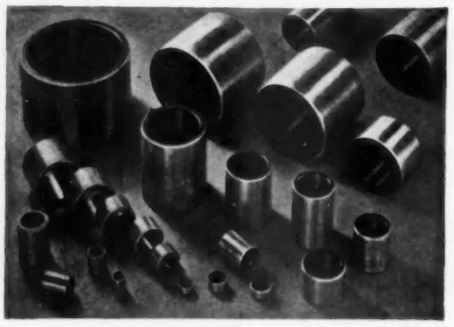

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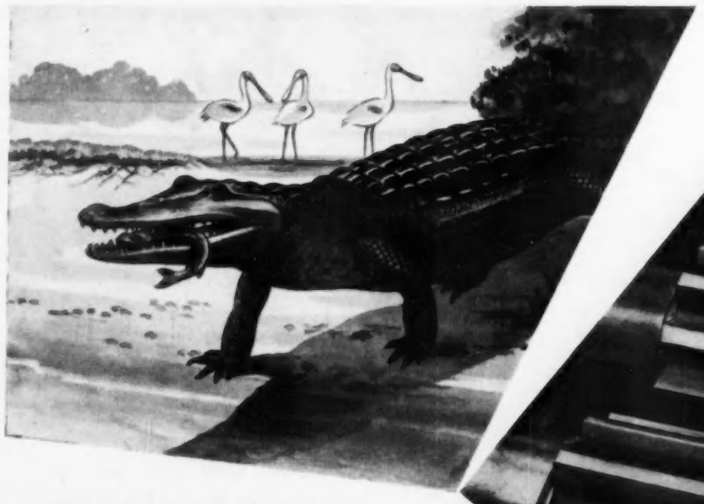

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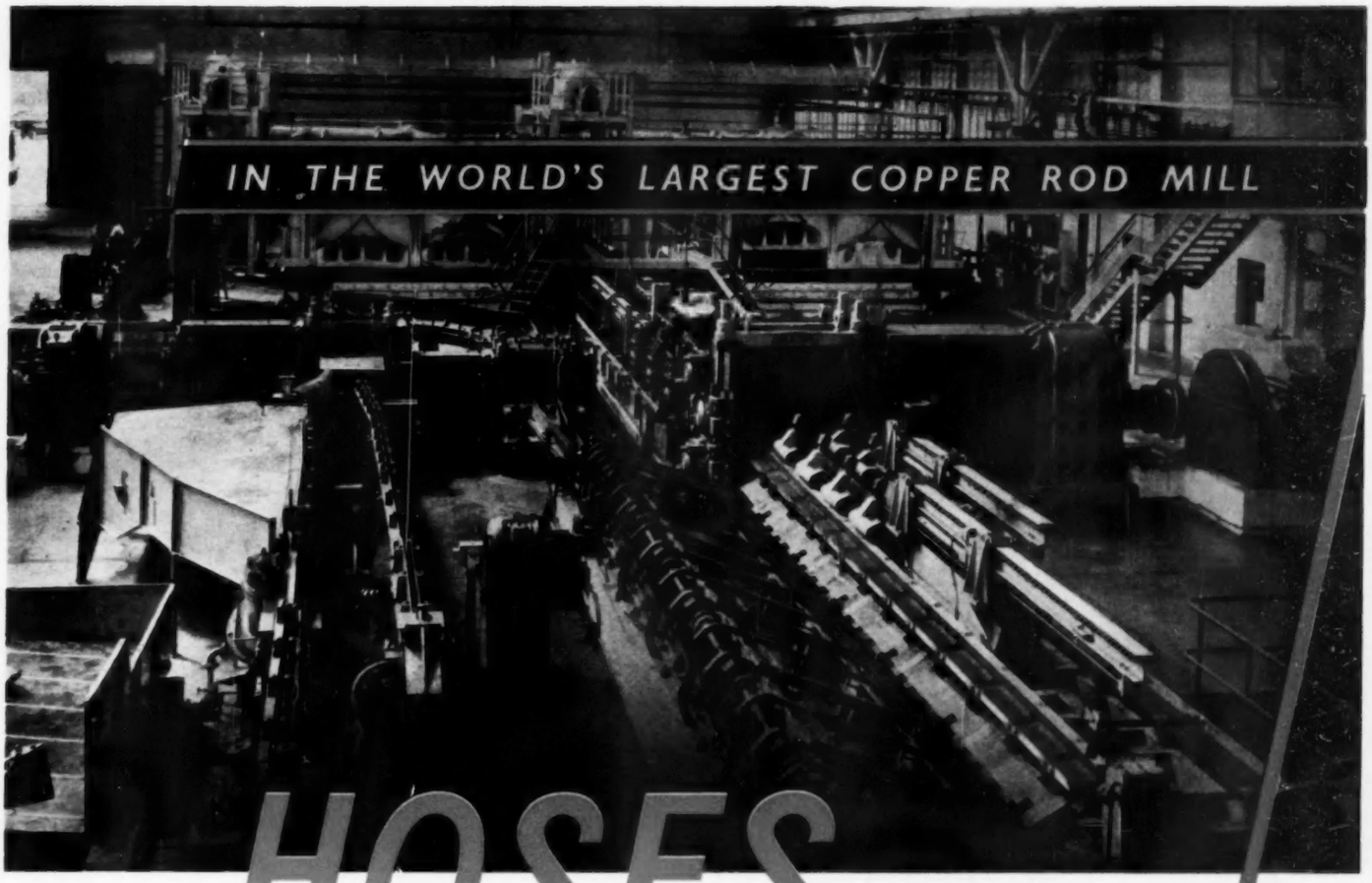

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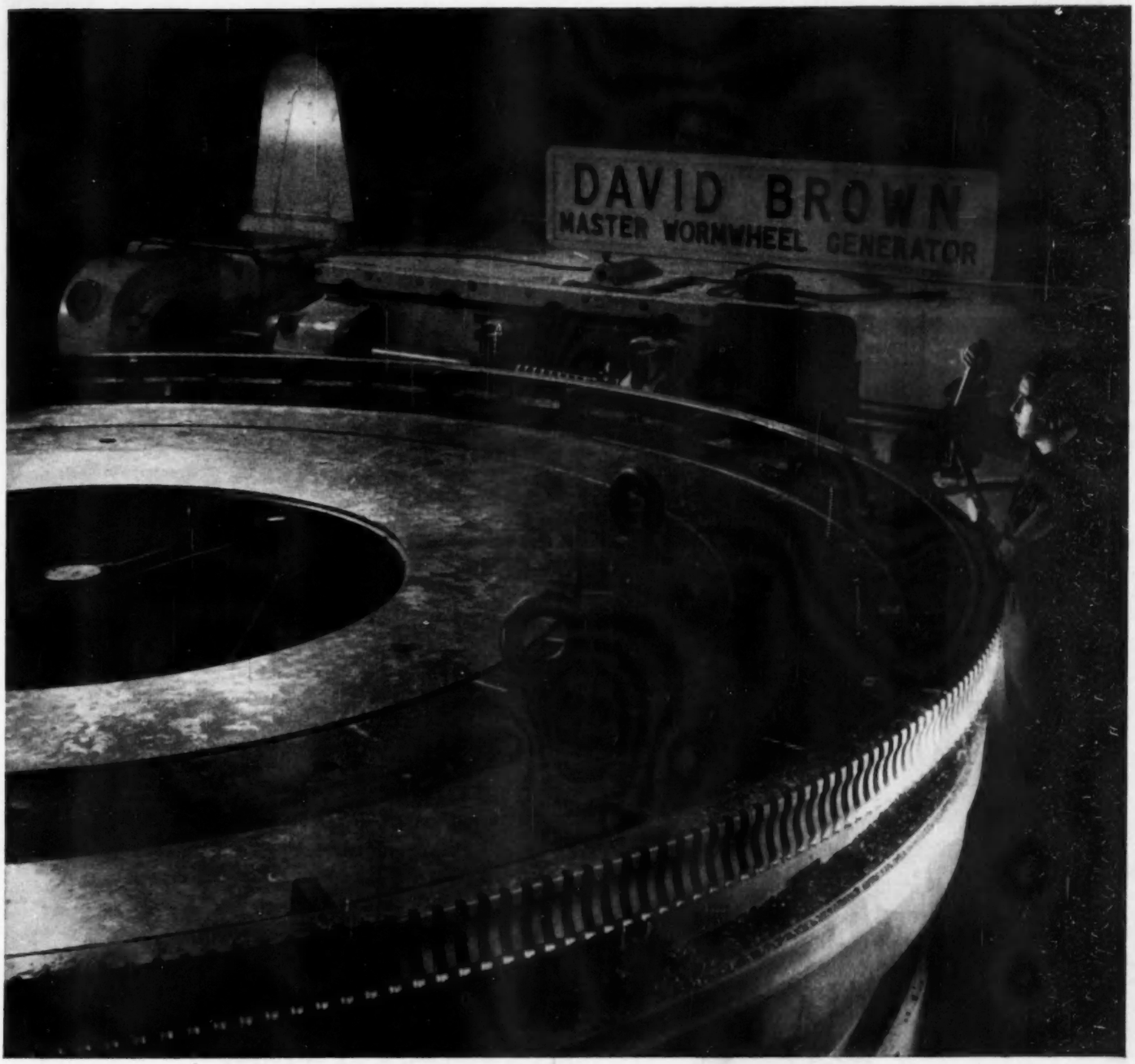

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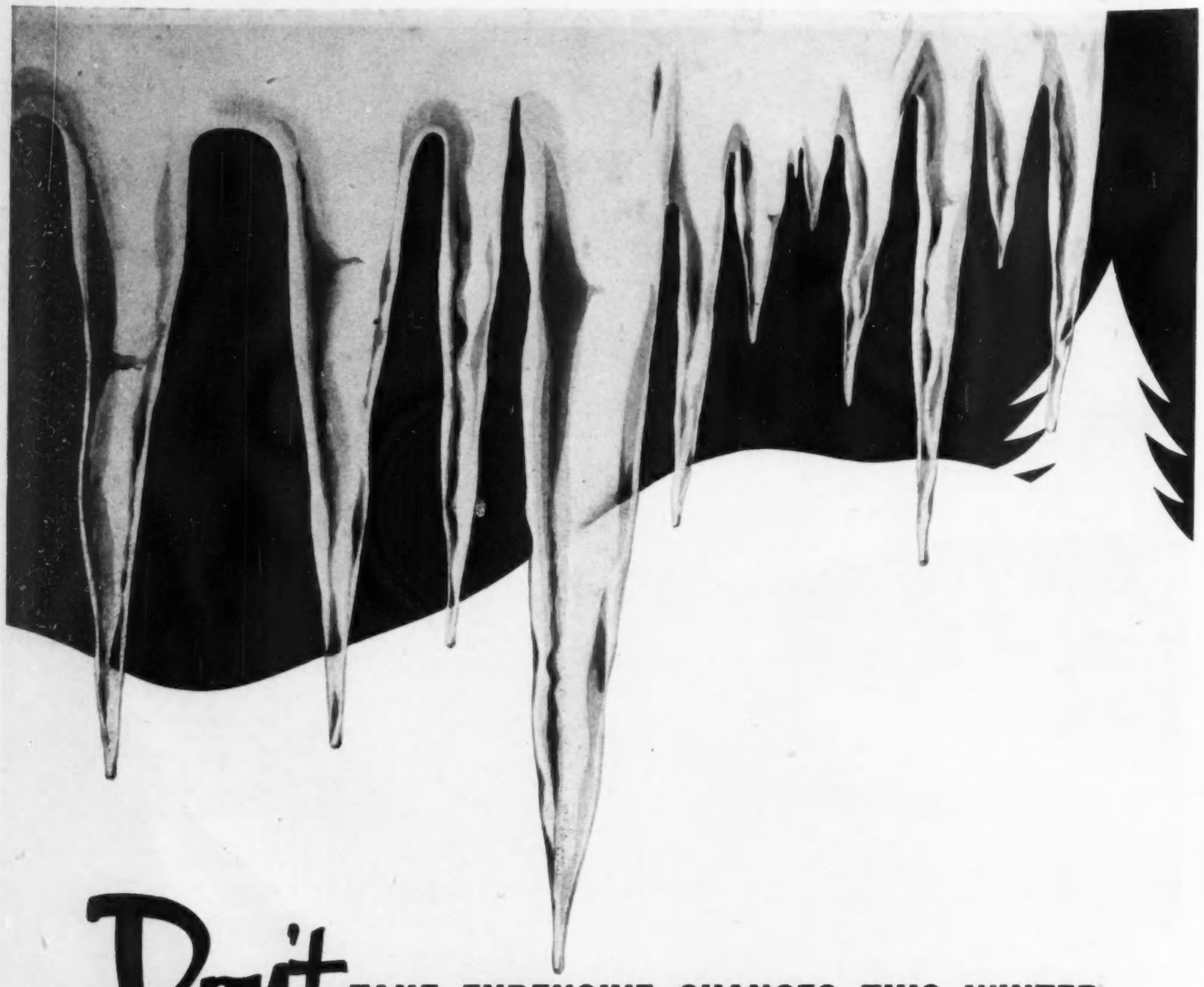

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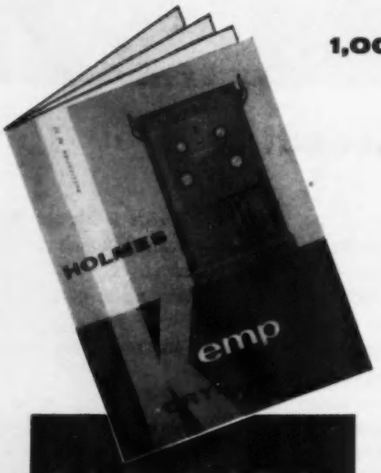

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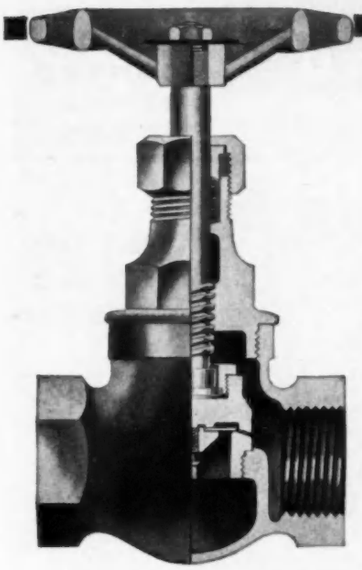
News from Hattersley



the Fig. 2016 'PRESEATOR' globe valve with the Flexible Titanium Disk*

This specially designed Hattersley valve incorporates a flexible pre-seating disk made of an I.C.I. titanium alloy which is exceptionally resistant to corrosion and erosion. As this seats before the main surfaces, pipe-scale is trapped and the main seating surfaces protected from the effects of wire drawing.

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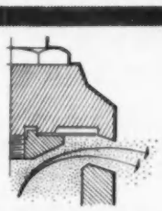
Suitable for steam at 200 lb. per sq. in. and 500° F.

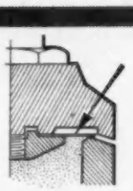
Please write for literature.

* *The Flexible Titanium Disk is protected by Patent No. 822147*

Over a period of years the outstanding merits of this Valve have been proved under the most arduous service conditions on many installations.



In open position free passage for flow directed across seating surfaces.



In 'Pre-shut' position flow and pipe scale held back by *Flexible Titanium Disk*. Patent No. 822147

Valve fully closed. Seating surfaces have passed through wire-drawing zone under virtually 'no-flow' conditions.

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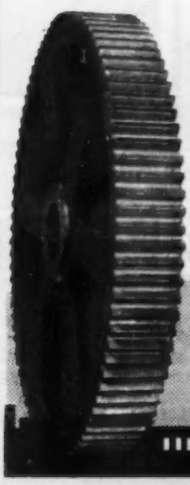

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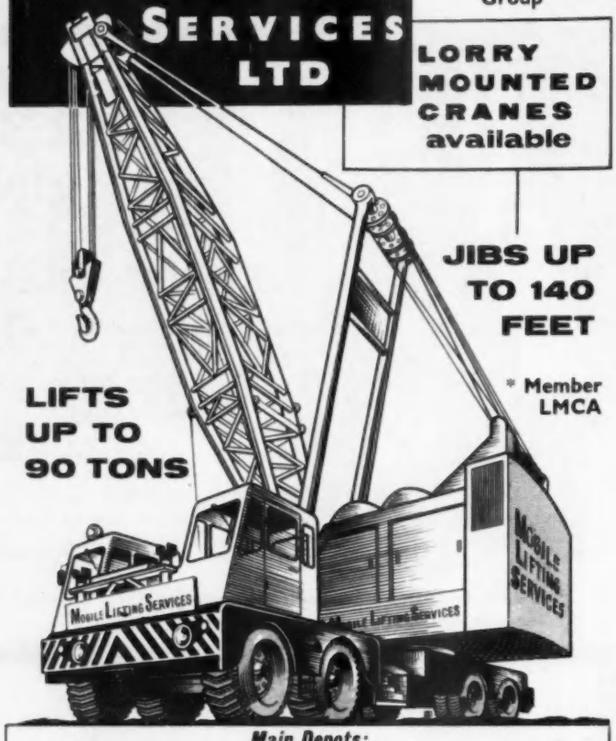

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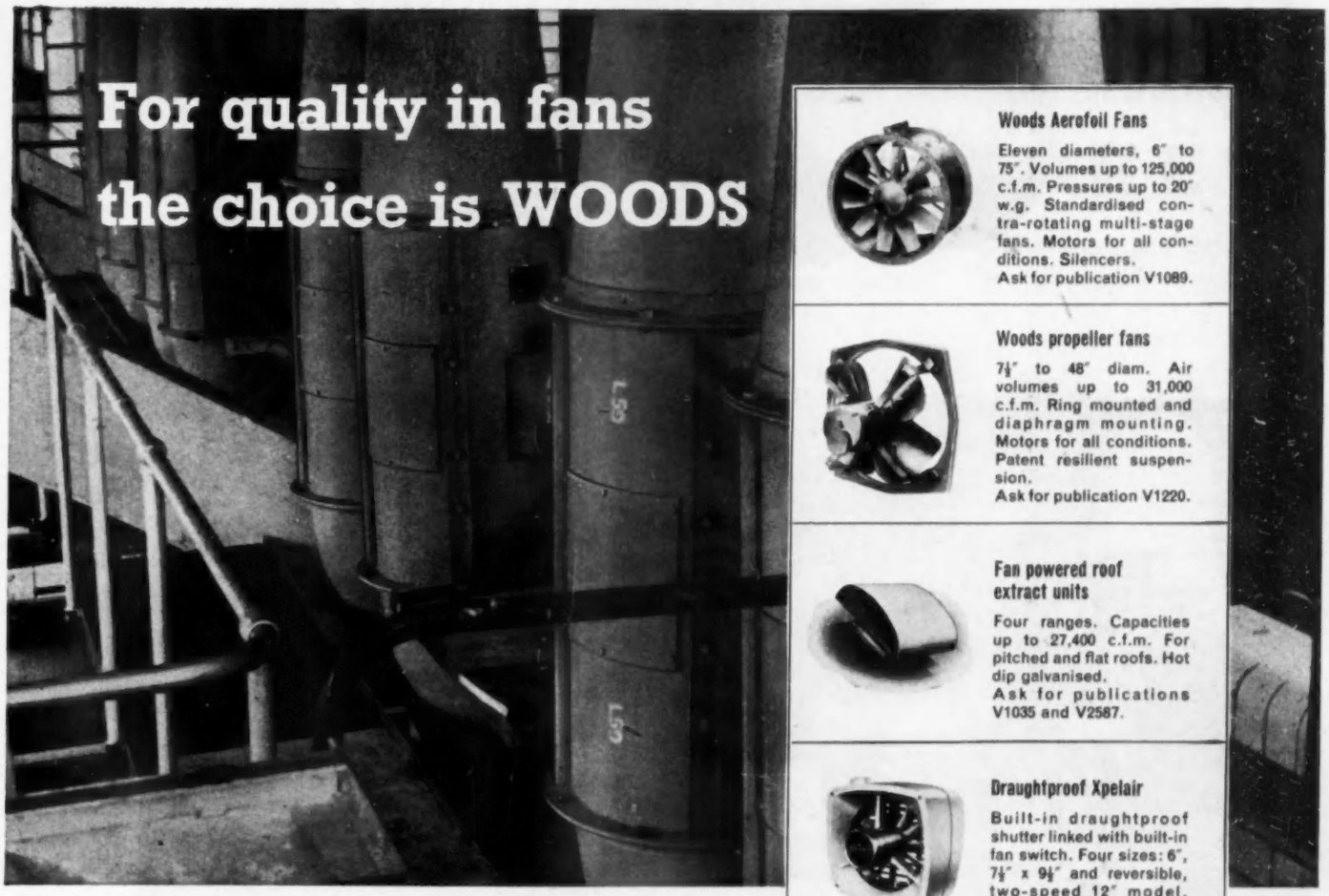

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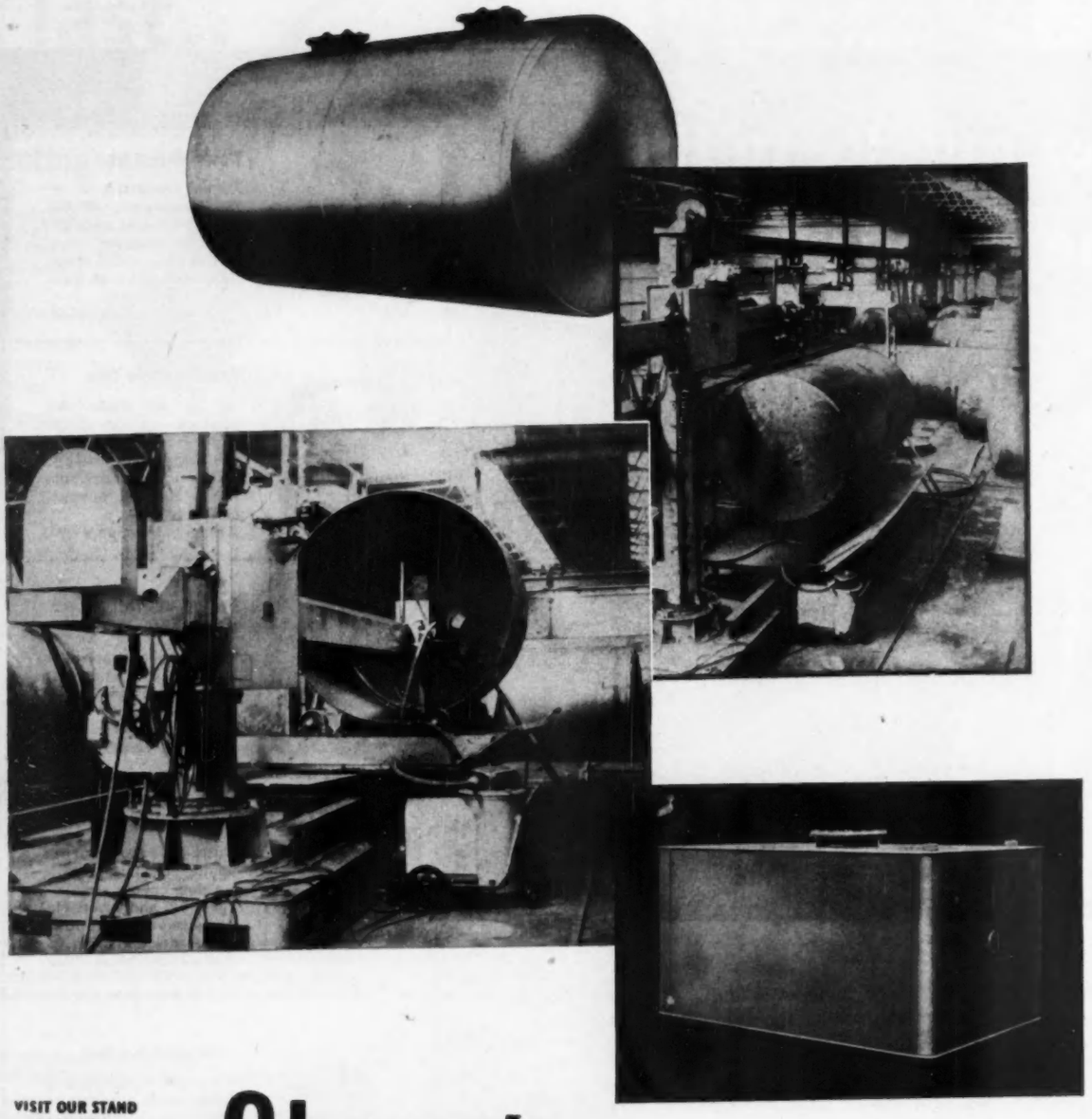

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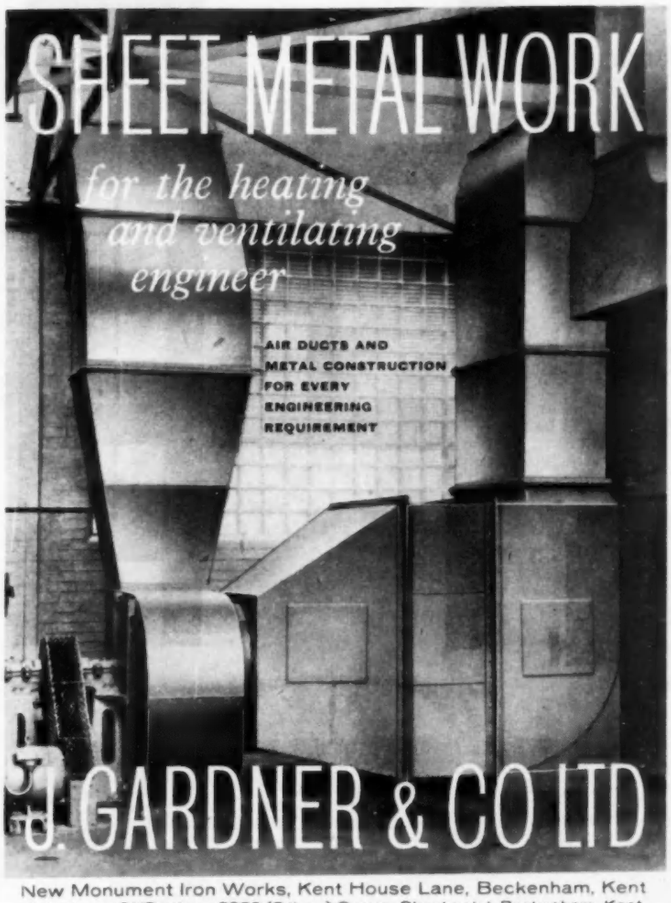
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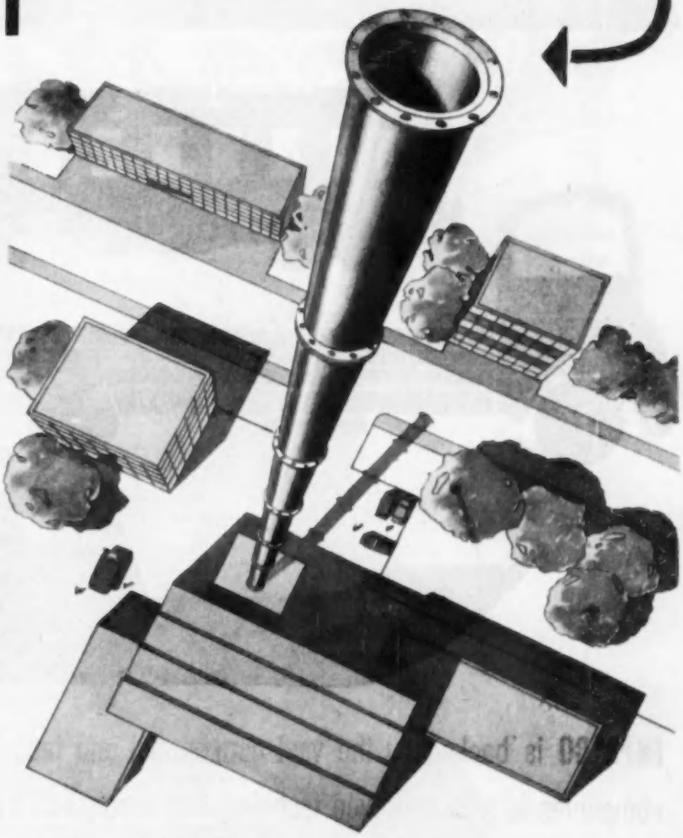

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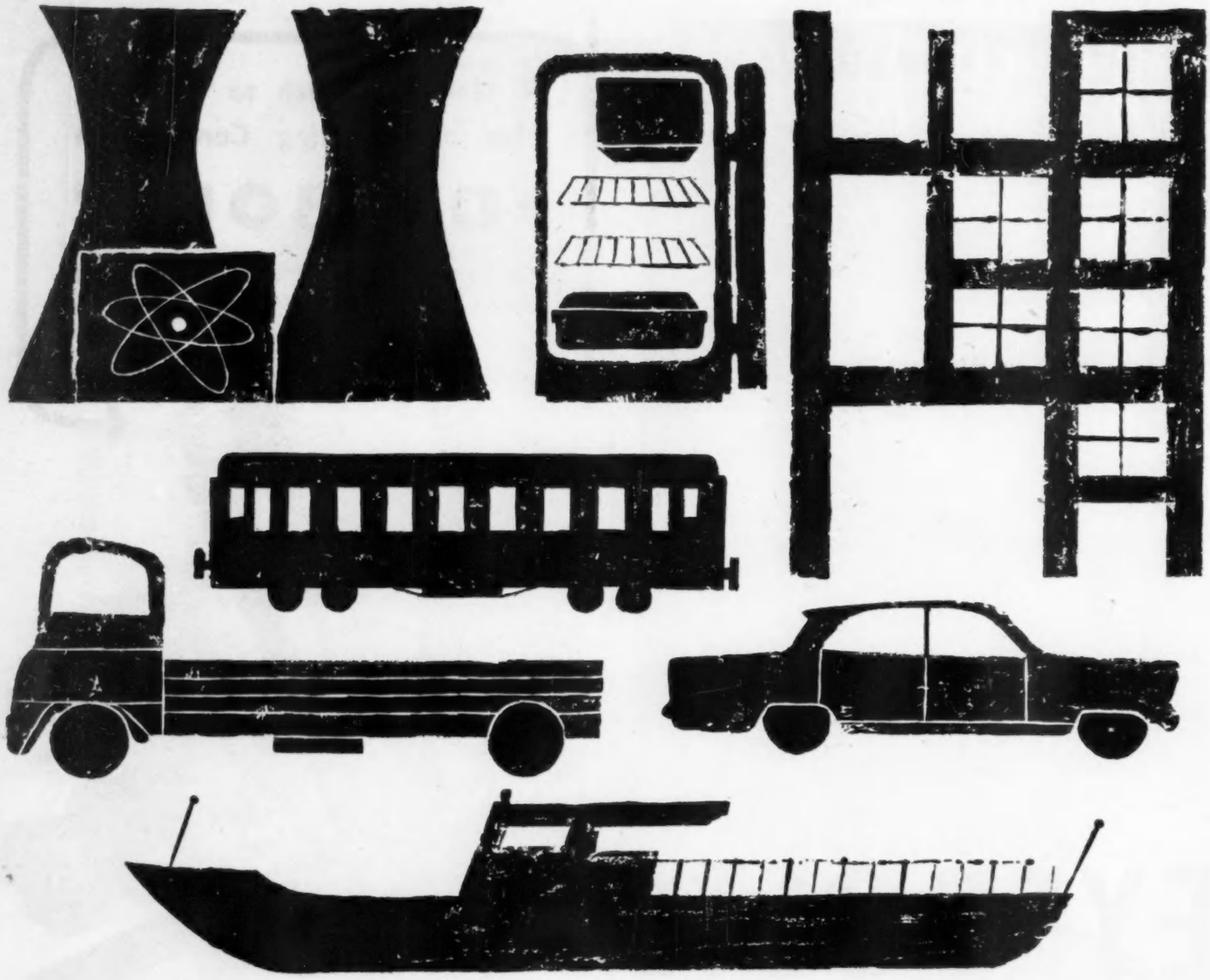

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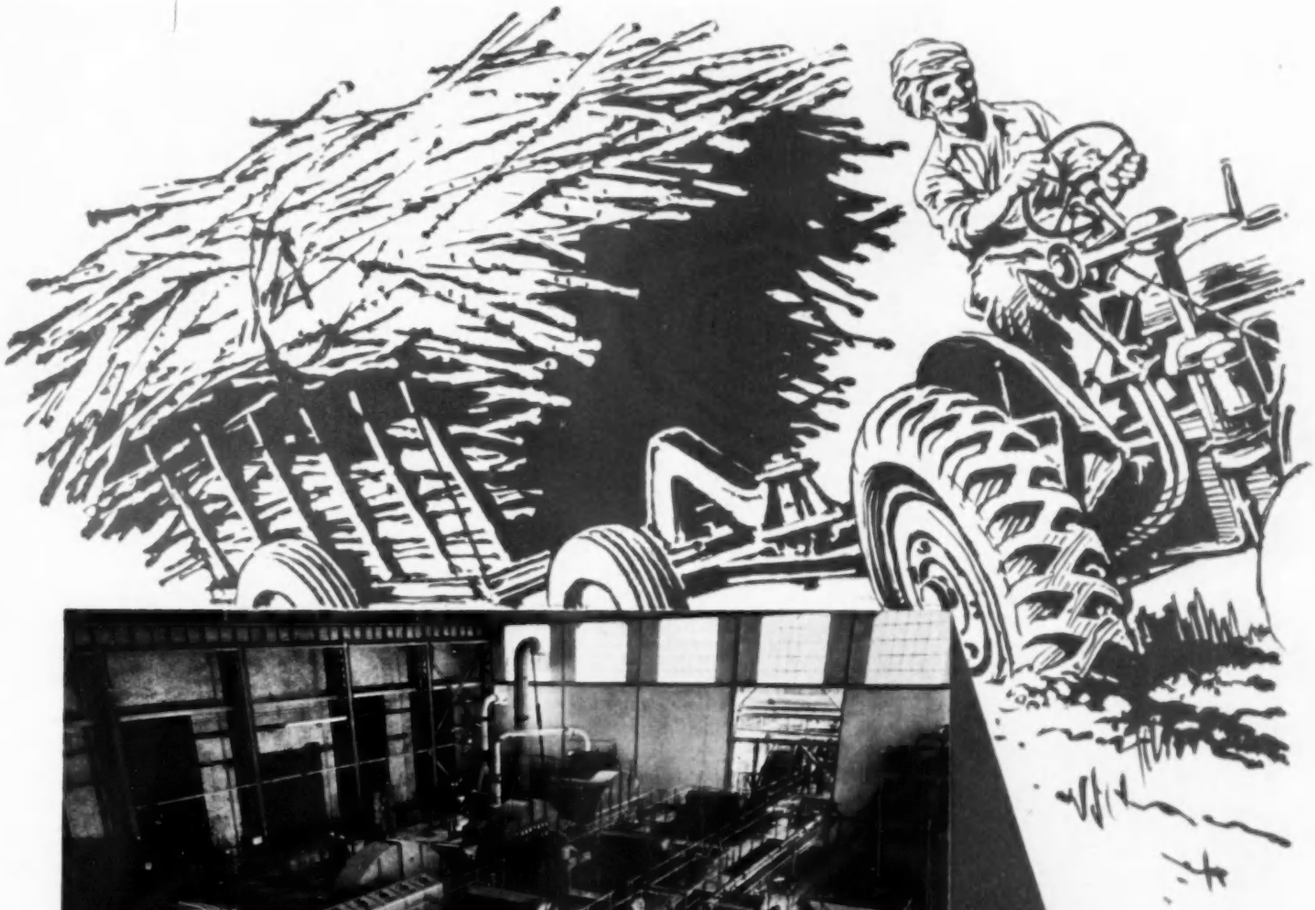

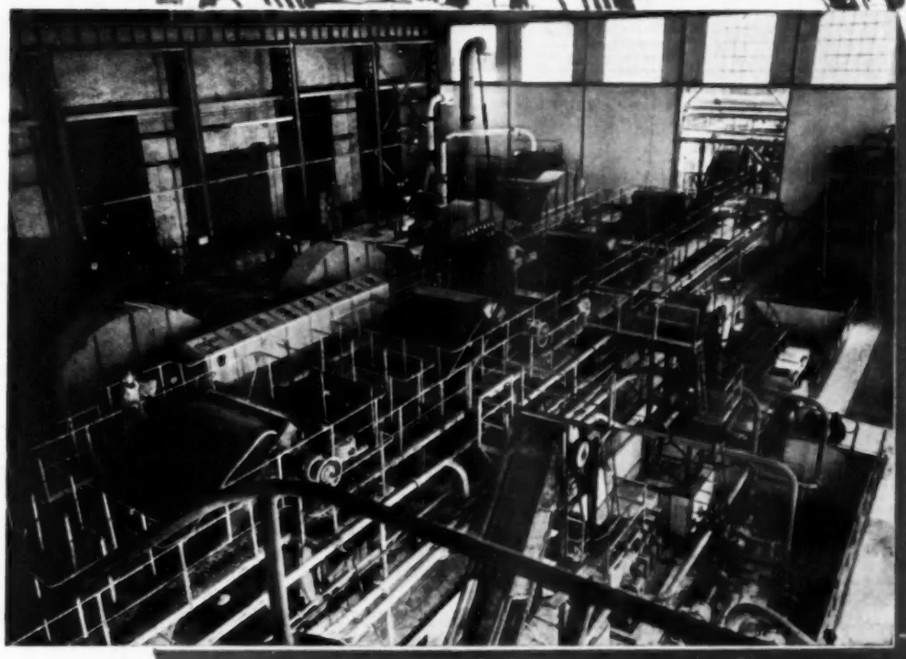

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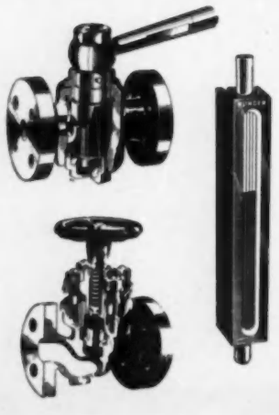

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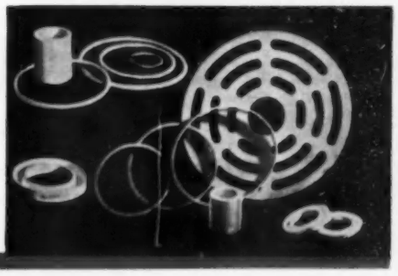

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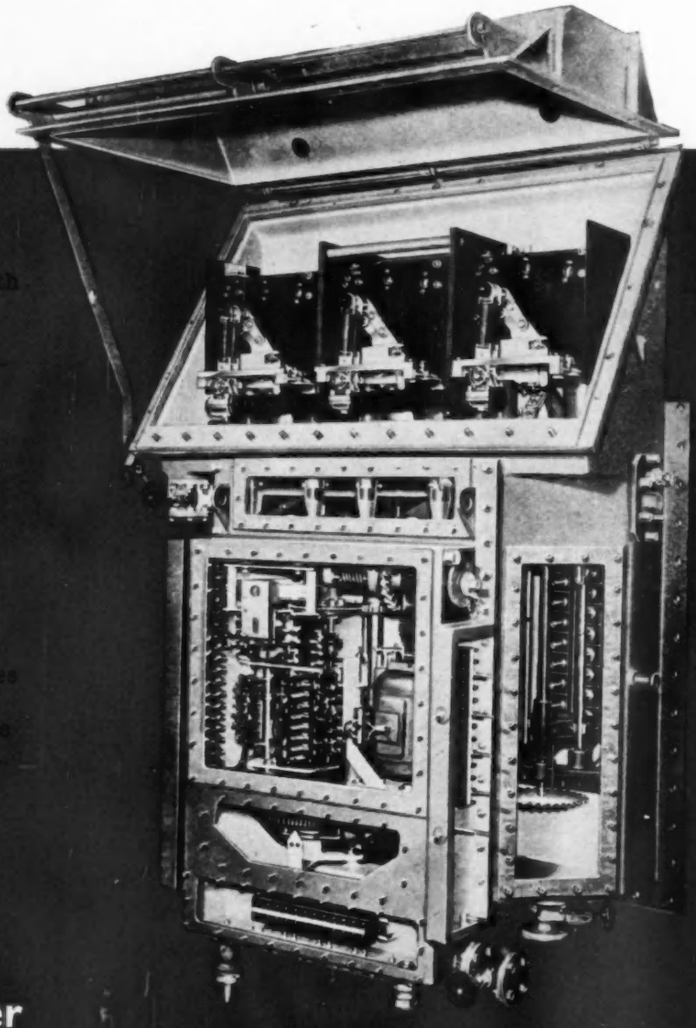

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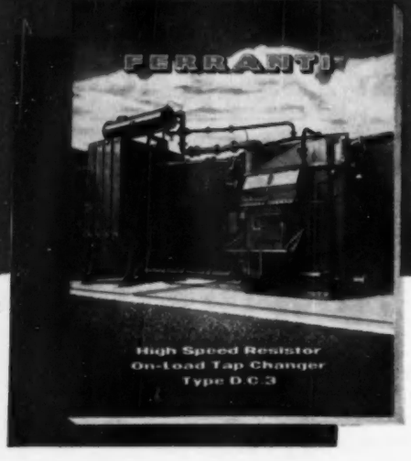

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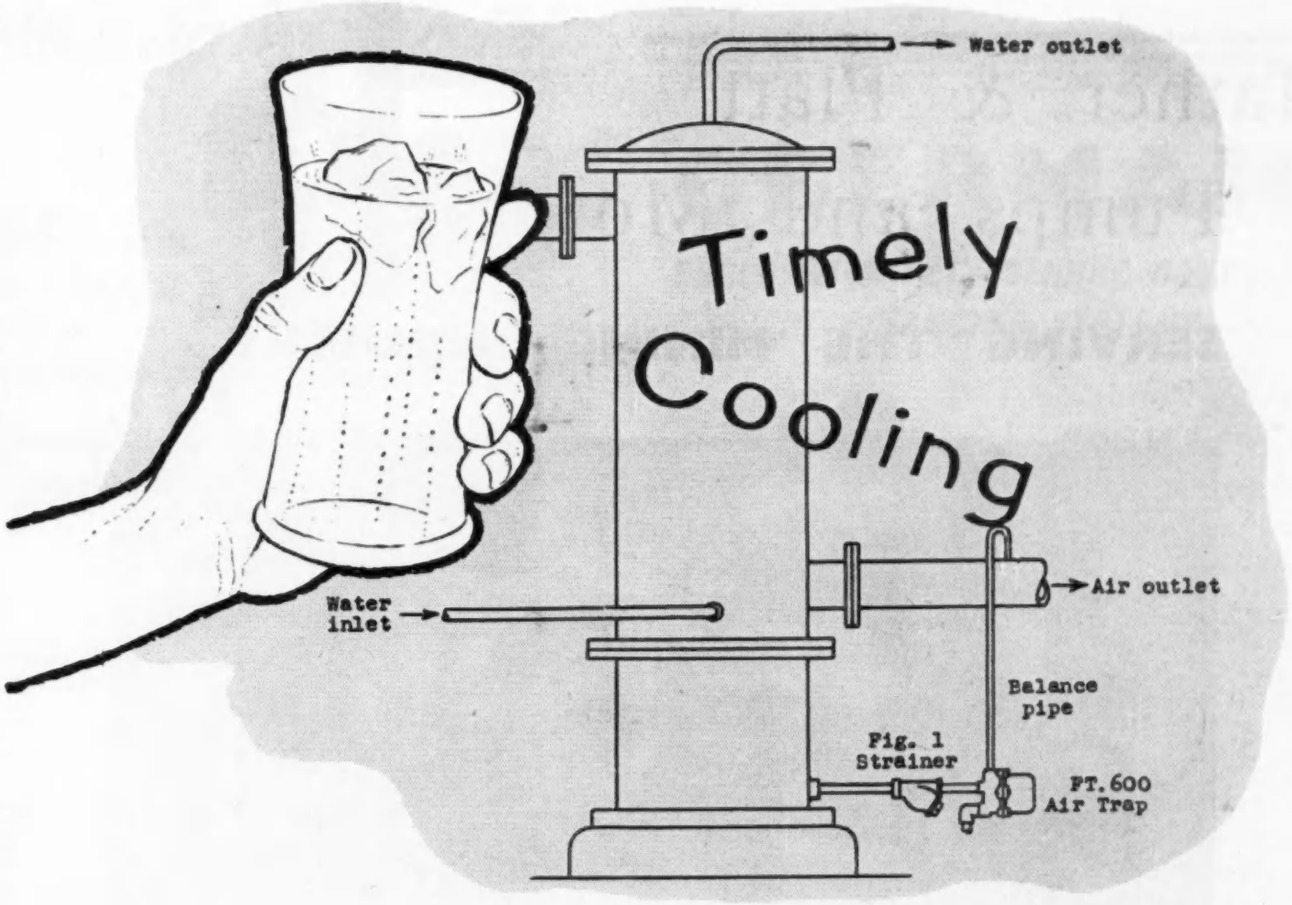

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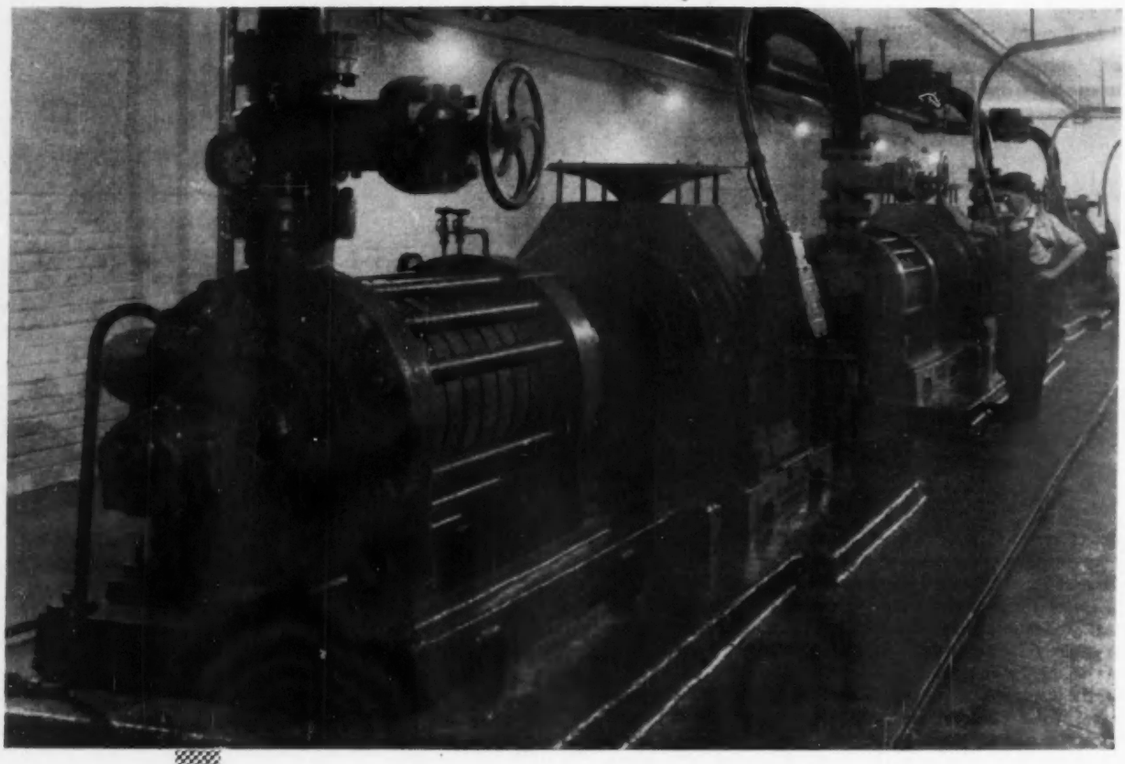

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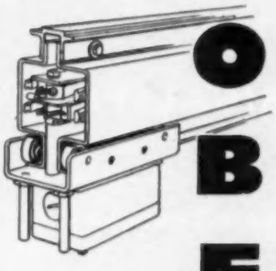

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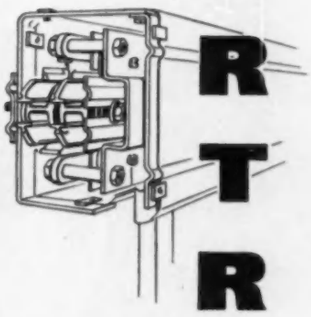

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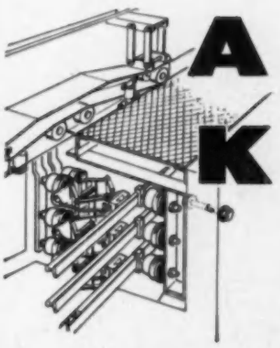

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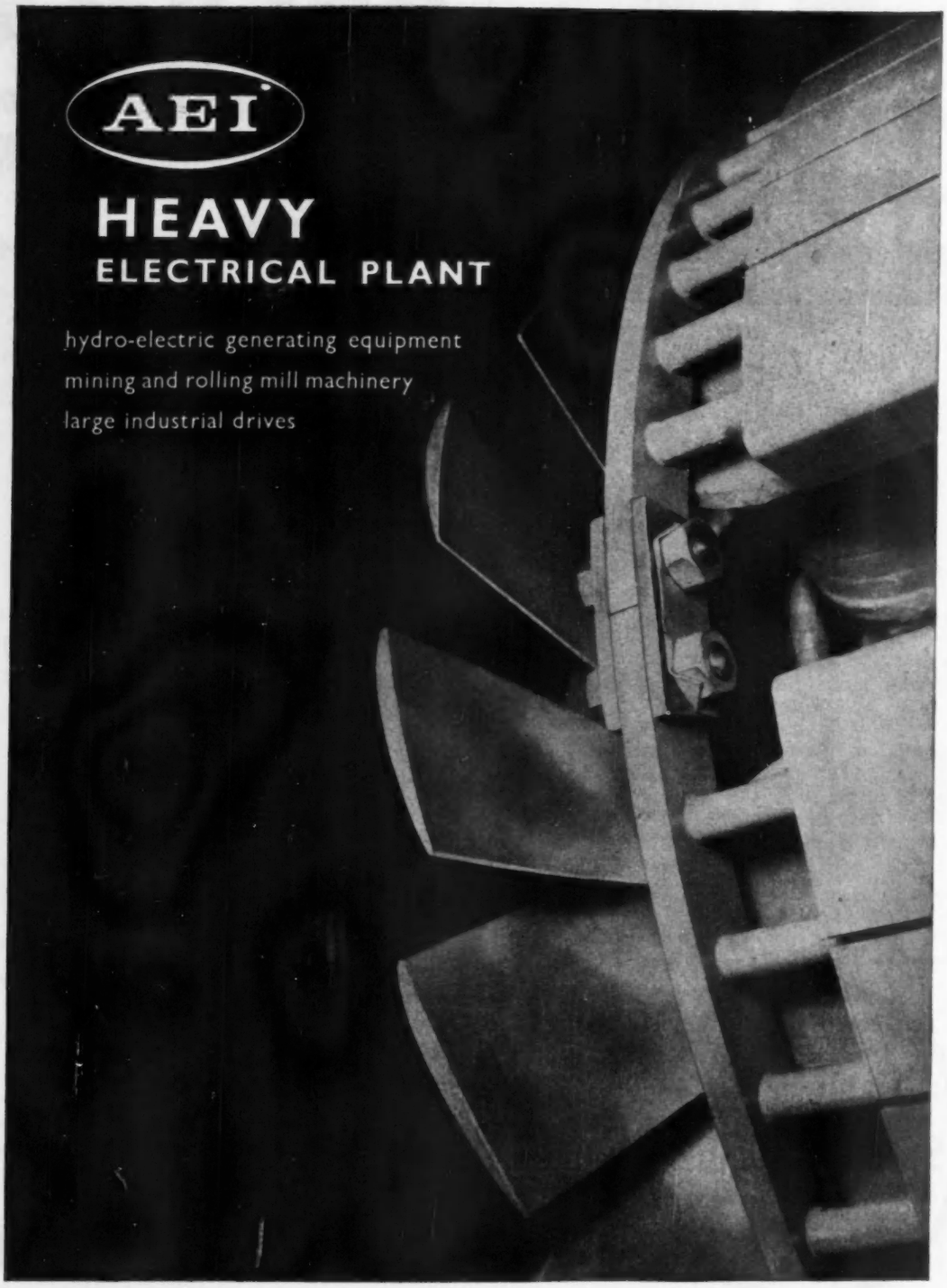

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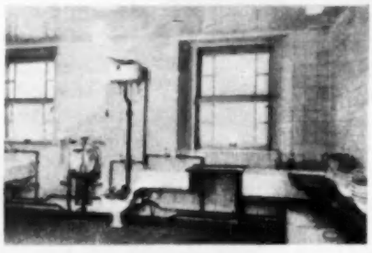

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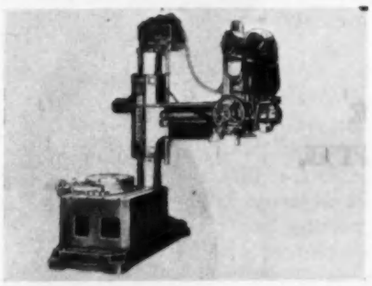

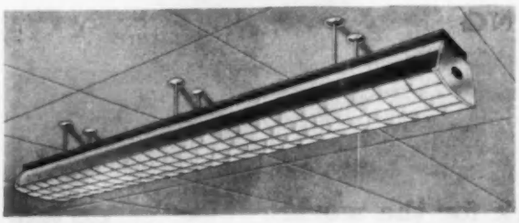

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Rawlplug fixing devices save you time and money

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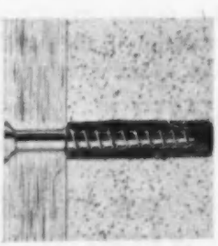

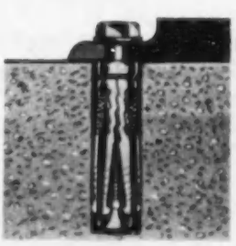

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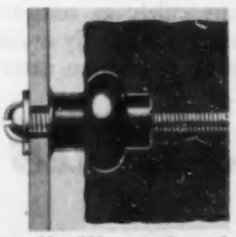

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RE-THREADING OF RODS WITHOUT HEAT TREATMENT

Coromant drilling is economy drilling

In addition to the advantages of easy handling, the Coromant Rope Thread helps to keep footage costs to a minimum—*thanks to precision engineering, high quality Swedish alloy steel and the smooth contours of the Rope Thread design.*

Sandvik Coromant—
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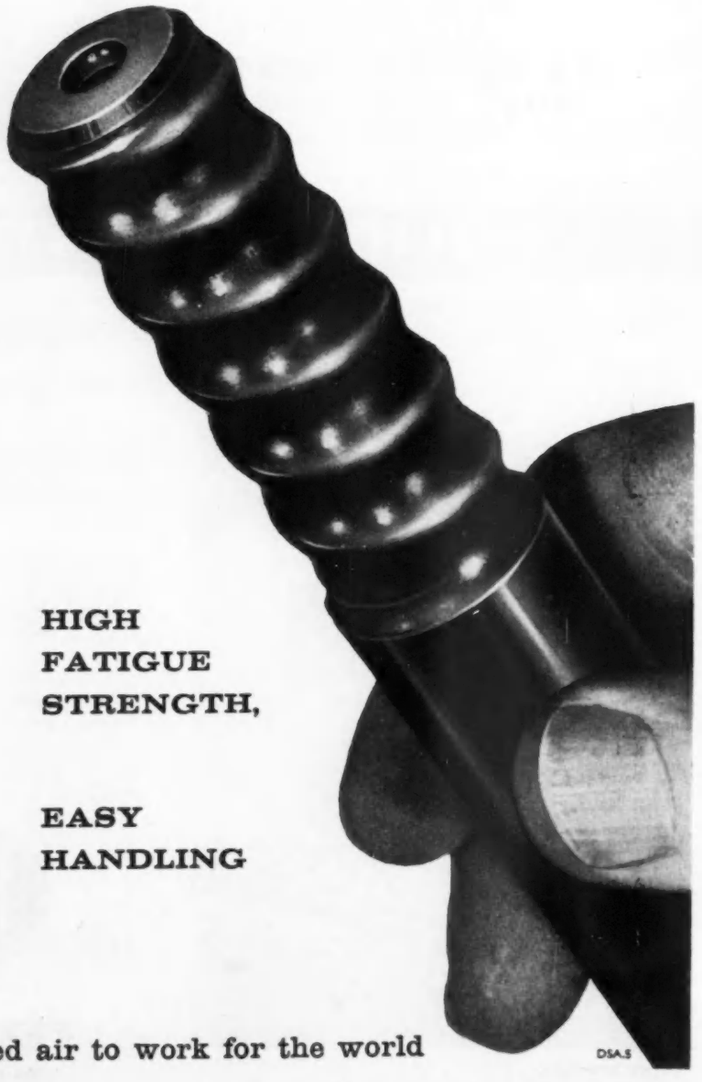
Sandvik Coromant drill steel equipment is sold exclusively by Atlas Copco—the world's largest organisation specialising solely in compressed air equipment. Further information is readily available from any Atlas Copco company or agent or from Atlas Copco AB, Stockholm 1, Sweden.



HIGH FATIGUE STRENGTH,

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THE ENGINEER

No. 5465 OCTOBER 21, 1960 Vol. 210

H.M.S. " DREADNOUGHT "

Nearly fifty-five years ago, Britain launched a warship of revolutionary design—H.M.S. "Dreadnought". She was the first all big gun battleship. To-day when H.M. The Queen launches a second "Dreadnought" at Barrow, another warship of revolutionary type will take the waters. But this time Britain is not the first in the field; already there are no fewer than fifty-six nuclear powered warships built, under construction or authorised for the United States Navy, including fifty-three submarines. None the less, the choice of Trafalgar Day for the date of the launch and the request to The Queen to perform the ceremony suggests that the Admiralty is anxious to emphasise the importance of the occasion. Underwater vessels have been units of the world's navies for the past sixty years. But they have, in fact, been submersibles —surface ships with the ability to submerge, for a limited time and at a very reduced speed, when required for attack or defence. Yet in both world wars these submersibles, with all their drawbacks, nearly brought Britain to her knees. To-day the underwater ship confronts this country with a menace greater than ever before. Nuclear-power plants have transformed her into a vessel which will remain permanently submerged while at sea and will operate as long as desired with the speed of a fast surface ship. No longer need she surface to concentrate with others of her kind to make a combined attack. Even the snort tube is no longer necessary, but in that connection it is well to note that this "half-way house" measure effectively prevented the detection of U-boats in the winter of 1944-45 by aircraft or 10cm. radar, which did so much to win the Battle of the Atlantic in 1943.

The launch of the "Dreadnought" must emphasise the now growing realisation that the H-missile is a deterrent only to its own kind of action and that the Admiralty visualises large-scale attacks on our trade routes. True, although not contributing to the deterrent, our Fighting Services are being organised to prevent the spread of "brushfire" campaigns. But if there is any meaning in the principle of economy of force, we do not require eighty new fast frigates and now also, with the "Dreadnought" and her recently ordered sister ship, anti-submarine submarines to deal with a few "Hottentot" underwater vessels. It must be emphasised that the anti-submarine submarine is the most effective means of profiting from the now greatly increased range of asdics. Russia has always been skilful in devising and laying new types of mines and both her minelaying and missile-firing submarines will avoid coming within range of surface vessels' asdic. Moreover the presence of thermal layers, due to the mixing of waters of different density and temperature, greatly reduces the effectiveness of asdics in surface ships. The presence of these layers has a marked effect on the passage of sound or super-sonic waves. A submarine which takes refuge in them can thus only be detected by a vessel of its own type, able to use her asdics and listen at any depth. In view of the time taken to build nuclear-powered vessels and the probability that in the not too distant future the Navy will take over responsibility from the R.A.F. for the British deterrent contribution, Parliament will clearly have to consider at an early date a problem of importance. Is Britain then to continue to give priority to measures to prevent an almost incredible war by building £40 million very large Polaris submarines? Or is the Royal Navy to be adequately prepared to safeguard the sea routes by building more "Dreadnoughts" and also surface ships armed not only with 6-inch guns but with Polaris missiles as the British contribution to the deterrent?

VOTING FOR AN INSTITUTION MERGER

Corporate members of the Institution of Civil Engineers and of the Institution of Municipal Engineers were last week sent voting papers to record their votes on the proposal for amalgamation of the two Institutions. There are 16,544 corporate members of the Institution of Civil Engineers and 5765 of the Institution of Municipal Engineers of whom 2270 are corporate members of both Institutions. As far as the Institution of Civil Engineers is concerned, there will be a special general meeting next February when a resolution approving the amalgamation will be put to the meeting. During the past year or so the *Journal of the Institution of Municipal Engineers* has published numerous letters arguing the pros and cons of amalgamation, but the members of the Institution of Civil Engineers appear to have taken less interest in the matter. The two sides of the argument can be quite simply stated. On the one hand is a feeling of enthusiasm for the smaller, more specialised Institution, and the greater intimacy amongst its members; on the other hand, is the principle that there should be unity in the profession. Sir Herbert Manzoni put this latter point succinctly in his explanation of the proposals. "The ultimate aim should be," he wrote, "that of one society of professional engineers whose corporate members should be Chartered Engineers. This would resolve the difficulties presented by the present multiplicity of titles which professional engineers have bestowed upon themselves during the past 100 years, and which have created such confusion in the minds of the public." The present proposals are intended as a step in the direction which Sir Herbert indicated, and it is considered that they might well set a pattern for future amalgamations.

It will be interesting to see how the corporate members of both Institutions will have responded when the results of the ballot become known. The need for unity has been stressed often enough, and when the arguments for it are marshalled together, they decisively outweigh the advantages of the present situation with, in the field of civil engineering at least, its main Institution and the various "splinter" groups. This is becoming more evident as, with the passing of the years, the work of engineers becomes increasingly important to the community, and so it becomes more necessary that the profession should be able to state its views authoritatively, and be held in

real esteem by officials and parliamentarians and the public at large. Equally, cross-fertilisation of ideas between specialists to promote broad and well-educated professional attitudes is necessary. Sir Herbert's ultimate aim is, however, rather far removed from the amalgamation now proposed, which would be more realistically assessed as the first step towards the concept of a unified profession of civil engineers as the term is now generally used—embracing eventually the half dozen or so institutions in this field alone. Sir Herbert stated, in developing his argument, that the various "splinter groups" had been formed to give facilities for the discussion of specialised subjects, but this could be done by the parent Institution, by its organisation into divisions and by special groups of which the traffic engineering study group is a recently formed example. The success of the policy of amalgamation will depend on the success of these group activities within the Institution. For instance a "Municipal and County Engineering Branch" is to be formed to serve the former members of the Institution of Municipal Engineers after amalgamation, and to deal with local government matters. Much of the resistance to amalgamation could probably be overcome if these specialised groups were not merely strictly formal, but if each one were given sufficient latitude to develop something of an atmosphere of its own, expressed as much in social events of its own choosing as in the character and subject matters of its meetings.

ELECTRICAL ACCIDENTS

The recently published report on "Electrical Accidents and their Causes, 1959" (H.M. Stationery Office, price 5s. 6d.) provides an interesting commentary on human fallibility. For the report shows that, as might be expected, nearly half the total of electrical accidents reported in 1959, under the Factories Acts, "resulted from ignorance, negligence, forgetfulness and inadvertence, whilst mistakes by persons other than those injured accounted for one-fifth of the total". With minor amendments this quotation might well be applied, out of context, to show that the unpredictable human element contributes to the cause of most accidents, particularly in the home and on the roads.

Of the four contributory causes quoted above the one that is most readily remedied is that of ignorance and the report under review devotes a good deal of space to an unobtrusive process of educating users in the principles of electrical safety. The report contains some interesting chapters on the newer electrical techniques that are becoming more widely used in industry. The importance of this kind of practical information cannot be overrated, particularly in industries where the user of electrical plant and equipment is probably not electrically minded. For instance, there is an informative chapter on the bearing of electronics on safety in industry. Another chapter on the electrical instrumentation and control of nuclear reactors takes the form of a general survey which it is hoped to develop into a more detailed analysis in subsequent issues of this annual report. Of more immediate interest, perhaps, is the introductory chapter which surveys, mainly from the safety aspect, developments in 1959 in electricity supply, in insulation, in arc furnace practice and in other fields, such as underfloor heating and arc welding.

An interesting sidelight on some of these figures is provided by the report's comments on accidents to engineers and skilled operatives in the electricity supply industry. It is concluded that human failure forms the weakest link in the chain of safety precautions. The report notes "some disturbing failures of plant, causing fatalities which the correct operation of safety rules would be powerless to prevent". But in most cases "there was some departure from the correct procedure laid down by the standing safety rules and the accidents resulted from some omission or slackness in their application". It would be wrong to conclude from this evidence that the electricity supply industry has a poor safety record. On the contrary, as the report acknowledges, the Electricity Supply Safety Rules, which have been in operation for over ten years, have been effective in keeping down the accident rate. Indeed the corresponding accident rate on high-voltage equipment in large factories is stated to be considerably greater, mainly because reliable safety procedure is not universally adopted. Here the report observes with satisfaction that industry generally is tending to adopt the basic principles of the Electricity Supply Safety Rules, including the use of permit-to-work systems, testing, earthing, and "danger" notices. But, inevitably perhaps, it is sometimes difficult to convince factory occupiers of the benefits of such a system "until an accident has illustrated the need beyond all doubt". With its detailed and penetrating analysis of accidents this report should commend itself to all industrial users of electricity who are wise enough to profit from the mistakes of others.

"JAMES WATT" DINNER

This year's "James Watt" dinner of the Institution of Engineers and Shipbuilders in Scotland was held, as a matter of pure chance, very soon after the premature publication in *The Times* of some details of the confidential criticisms which have been made by a committee of the Department of Scientific and Industrial Research of the shipbuilding industry. It was natural in the circumstances that all three speakers at the dinner, the President, Mr. J. Brown, in his "Remarks," Sir W. Nicholas Cayzer, in proposing the toast of "Engineering and Shipbuilding," and Mr. E. L. Denny, in replying to it, should have referred to those criticisms. None, however, really set out to discuss them. Sir Nicholas gave his own views on the subject and they turned out to offer some support to what is reported to be the D.S.I.R. case; but we gathered the impression that the representatives of shipbuilding present at the dinner were quite ready to agree to some extent with his strictures or at least to admit that they contained matter which well deserved discussion. His main points were that the yards needed to get together development teams to study how to apply recent research and development work as soon as possible; that there were too many yards and, more particularly, too many engine building firms; and that there could in his view be more standardisation in ship design and construction. But he advised the industry not to be too much upset by the D.S.I.R. report. It was better to welcome criticism than to repel it, because criticism stirred up the mind to new thinking. In his reply Mr. Denny clearly thought that a ten minute after-dinner speech—the period the Secretary had allowed him—was not the time to discuss a large and controversial subject. He contented himself by pointing out that if rationalisation within the industry meant amalgamation of small firms into large ones it might not turn out to be good policy. One could not judge efficiency by mere size. Small firms had advantages, as, for example, in maintaining good human relations. Rather than adopt

amalgamation it might be better to build up a structure of parent and autonomous specialist firms. Listening to these speeches and talking informally to those attending the dinner we came to the pleasing, but we hope not complacent, conclusion that the leading article entitled 'Shipbuilding Criticised' in our last issue reflected pretty closely the general feeling of shipbuilders about the whole matter.

CRIB REVOLUTIONARY IN GREECE

Many have been the ingenious ideas thought up by examinees to cheat examiners. One idea which, if successfully carried out, ensures success in the examination, is to get a sight beforehand of the paper to be set. Definitely by crook (though possibly with a hook) one or more copies of the paper, known to have arrived in the headmaster's study, need to be acquired the night before the examination sitting. But in real life, as compared with children's books, we imagine that object has more often been achieved through some carelessness on the part of the examiners than through the ingenuity, the daring, or the initiative of the examined. Less desperate, of course, are attempts to aid the memory by writing out equations upon some suitably inconspicuous object which can be introduced easily into the examination hall. It used to be the cuff, which, when starched, provided a suitable and an easily concealed surface. But nowadays starched cuffs have gone out of fashion so that if worn solely for the purpose of an examination they have become rather too conspicuous. Instead, we understand, it has become more usual to insert a suitably inscribed slip of cardboard in the back of a slide rule; or even to get a confederate to write the desired information on the palms of the hands. Of course a weakness of all such methods is that not really very much information can be inscribed on the limited space available; and the odds are rather high that the information so inscribed will turn out to have no relevance to the questions set. It may be worth while, therefore, to find out beforehand (or to remember from past bitter experience of chewing one's pen over a sheet doomed to remain blank) what kind of paper is likely to be issued in the examination hall. If a supply can be obtained, several sheets, upon which there has been inscribed all the information which could possibly be required, can be introduced into the examination hall under the coat. Shortly afterwards it should be possible openly to expose these sheets to view since they will take on the innocent appearance of completed examination sheets. Care, of course, is needed to ensure that none of these interesting sheets gets mixed up with those carrying the examinee's answers to the questions, lest it appear in due course before the startled eyes of the examiner. But then an examinee exhibiting so low a level of competence would not deserve to pass the examination anyway! Even if an examinee is not prepared to incur many risks or to take much trouble beforehand, he need not give up all hope of success if the questions defeat him. Should the examination hall be crowded it may be possible to gain valuable clues by glancing covertly at what neighbours, before and to the side, are writing down. Too much reliance, however, should not be placed on this method. It may well turn out that the examinees before and to the side feel equally dependent on their neighbours! In such circumstances nothing can be more embittering then to listen to the excited squeaking of a pen, inaccessible, behind.

Alas! Examiners, having had experience of one generation after another of examinees, know all these tricks and many others, too, and also all the answers to them. It is deplorably hard to deceive them. Yet what opportunities to do so modern science provides! Never in our wildest dreams at school and college did it ever occur to us that an accomplice without the hall with access to all necessary textbooks might be able to communicate the correct answers to an examinee within the hall, unbeknown to the examiner. The Greeks have always been ingenious and it is to a Greek student that the credit for so revolutionary an advance must be awarded. In Athens, recently, an examinee got his fiancée to register, besides himself, for the examination. Thereby it became possible for her to obtain a copy of the examination paper and to carry it out of the examination hall. Within some nearby attic a confederate lay concealed, surrounded by every textbook which might be required. Using a home-made transmitter he sent information to the examinee within the hall, who used a pocket-sized transistor radio set to receive it. By means unspecified the examination authorities became aware of these transmissions; but they were able to determine neither from whence they came nor to whom they were directed. In that situation they thought at first that they would have to cancel the examination. But professors are not easily outwitted. The delinquent was uncovered. The authorities took a full recording of the transmission. When taxed with the damning fact that his manuscript paper corresponded exactly with the recording the erring but ingenious examinee confessed!

The Engineer—100 Years Ago (OCTOBER 19, 1860)

"The Electric Telegraph"

"By the methods now in use about 2,000 words per hour is the utmost capacity of a telegraph line, the speed of working depending upon the condition and length of the wire. Dr. L. Bradley, residing in New York, who has been studying for several years to discover a means of facilitating the transmission of signals, has invented a plan by which he can transmit 15,000 words per hour, using the signs constituting the Morse alphabet, which are generally used in Europe and America. This is at the rate of four words per second, the highest number reached by the ordinary method of operating being only thirty-three words per minute, Dr. Bradley found, however, on applying this improvement to a long circuit, that the relay magnets refused to work at half this increased speed. After spending several months in attempting to remove this difficulty, he has discovered a relay magnet capable of acting at the rate of 10,000 words per hour, or five times as fast as those now in use."

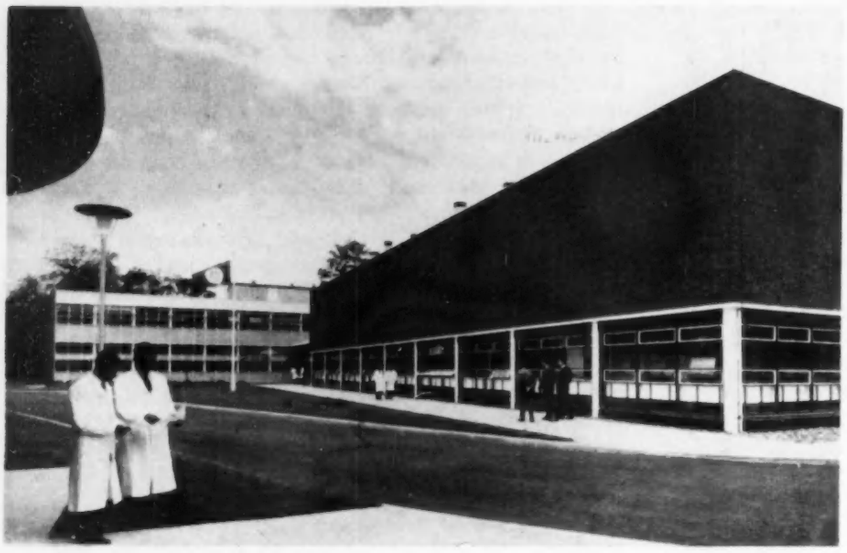
"The New West-end Railway Station and Hotel"

"By the side of the railway station, and fronting Belgrave-place, there is in course of construction a magnificent building, called the Grosvenor and West-end Railway Hotel. It is the property of a company, and the contract price of the building is £100,000.

"The hotel is expected to be completed about next autumn, and when finished will be one of the finest of buildings of which London can boast; being of solid stone, and not an outer covering of deceptive cement over brick, it is calculated to last for centuries."

Combustion Laboratory at Egham

Since 1956 the activities of the Shell Central Laboratories have been steadily consolidated at Egham and recently the facilities have been increased to include the Combustion Laboratory. The latter was established at Fulham in 1927 but increasing demands of development and technical service made larger premises essential, so that a new laboratory has been built at Egham.



General view of combustion laboratory at Egham

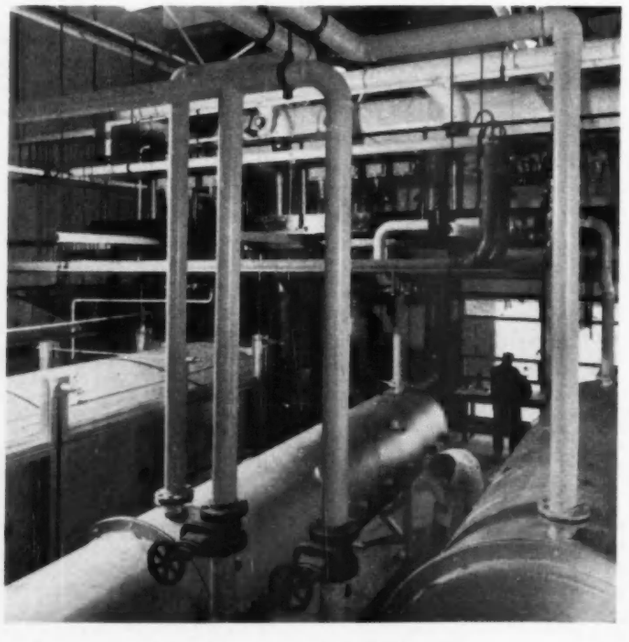
SINCE 1956 the activities of the Shell International Petroleum Company, Ltd., have been steadily consolidated at Egham, Surrey, and to the existing sections there has been added recently a combustion laboratory. This had been located at Fulham, and since 1927 onwards its activities has steadily expanded until it was imperative that new quarters be found to enable the increasing demands of development and technical service to be met, and so the move to Egham has been made. The new laboratory, of which we reproduce an outside view, and for which the architects were Walker Howard and Cranswick, consists of three main sections, namely, the service, test and administration blocks. The first accommodates stores, boiler-house, plant room and fully equipped maintenance shops, while the second is used for large-scale test work which is carried out in a combustion chamber room, boiler-room and the general test room. In the third block there are, in addition to the normal office facilities, a number of small laboratories for specialised work. Extensive services are incorporated to meet the widely varying needs of the many research projects undertaken, and there are, in addition to electricity, heating and ventilation, some twenty-two services, including high, medium and low-pressure air, town gas, propane and butane, fuel oils ranging from kerosene to 3000 seconds oil fuel, mains water, cooling water and provision for variable voltage supplies. An important point about the services is that all have been left uncovered so that each is immediately accessible to permit adjustments to suit modifications to equipment.

In welcoming guests to the laboratory Mr. C. B. Davies mentioned that Egham is one of several Group combustion laboratories and that it forms part of the Marketing Organisation. The work is to advance the knowledge of the behaviour of fuels in equipment so as to ensure the highest standards of performance and reliability, and also to solve problems posed by modifications to equipment while at the same time developing new fuels and techniques. As indicative of the wide range of research and development work, attention was drawn to a high output fuel-oil burner, a kerosene cooker for use in the Sudan, a 2,000,000 B.Th.U. central heating boiler burner unit and a cooker, using liquid gas, developed for manufacture in India.

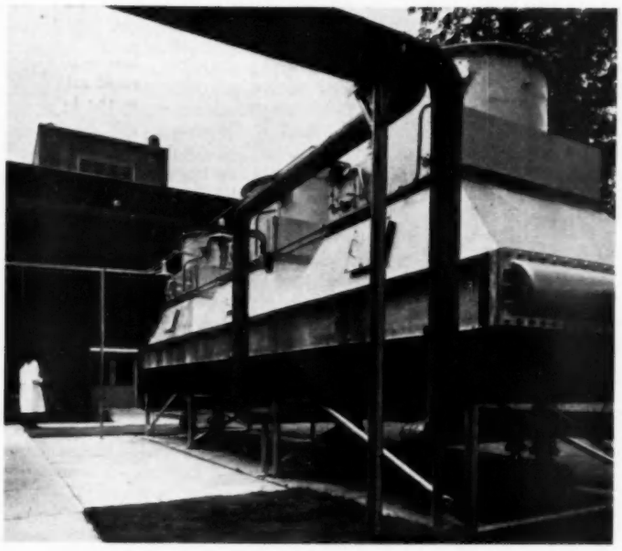
During a tour of the laboratory the "Doka" cooker developed for use in the Sudan and to prevent deforestation by using oil instead of wood was on view. The unit is of simple construction and includes a kerosene burner operating on the gravity feed, vapour jet principle together with provision to overcome the pulsation inherent with gravity feed. The stack solids rig, originally constructed for work on solid particles carried in flue gases produced from an oil burner, is at present being used for the assessment of flue gas corrosion and in the test section, where the temperature is about 400 deg. Cent., four probes cooled with liquid having a constant boiling point have been inserted and operate at different temperatures. Provision is made for measuring the amount of oxygen present and the SO_3 content of the gases, while a dew point meter records the temperature at which acid condenses.

There are four rigs for testing nozzles, in-

Wax spray rig for determining particle size



View of large combustion chamber room



Air-cooled heat exchanger

cluding one having a maximum capacity of 25 gallons per hour at 400 lb per square inch for testing nozzles on distillate oils, a "Patternator" for measuring spray distribution, and a third, for testing nozzles on preheated heavy oil, which will have, when modified, a capacity of 800 gallons per hour at 1000 lb per square inch. Measurement of size of particle in the spray is effected in a fourth rig in which a special wax is used to simulate the fuel, and the spray is enveloped by a water curtain so that the particles freeze in flight. Our illustration shows the wax spray rig used for determining particle size. These particles are sized by sieving. Since oil fuels have to be burnt in cold as well as hot climates, and the pressure jet nozzle is sensitive to fuel viscosity, the laboratory is equipped to check both burners and fuel at low temperatures. Burner and fuel supply are placed in a cold room and the burner fired into a boiler located outside and starting characteristics at low ambient temperatures recorded. A development of the Shell-Y- burner was on view and this is the Spill-Y-Burner, which is a small capacity, variable output, medium air-atomising internal-mixing sprayer which has the metering unit in the burner nose. Oil, at constant pressure, is fed via an intermediate duct and part is discharged to the air/oil mixing chamber while the remainder passes through a central spill tube to the pump section. Atomising air is supplied at 80 cubic feet per hour and 5 lb per square inch, and tests on gas oil have indicated that the turn-down is from 3·2 to 0·1 gallons per hour and that while using oil of 220 seconds Redwood at 100 deg. Fah., the burner has operated at 0·15 gallons per hour.

The tunnel burners exhibited were developed at the Combustion Laboratory to use propane and are of simple construction and have a heat release of more than 65,000 B.Th.U. per hour. Ignition is by high tension electric spark and the burner produces a very hot and high velocity gas stream to give rapid heating by forced convection and by direct impingement. Another burner seen was a high stability L.P.G. unit burning a propane/air mixture and having a high turn-down ratio in excess of 100 to 1. Stable combustion within a wide range of air/gas ratios has been achieved by directing premixed propane and air from the burner head annulus in a divergent cone. The toroidal vortex induced brings back part of the combustion products down the axis of the cone to join the emerging propane/air mixture and ensure that the flame root remains established. A demonstration showed the facilities available for an investigation into the design factors affecting air entrainment and flame characteristics with oil burners for open hearth steel furnaces. The facility, which can be seen on the left of our illustration giving a general view of the large combustion chamber room, can test burners and combustion conditions up to 50 gallons per hour and the steam atomising burner on test was firing into a furnace built to produce high temperature operating conditions. Connected to the chimney system are two water-cooled combustion chambers for use where the burner is intended for low temperature applications.

Also on the research programme is an assessment of the overall performance of a fully automatic preheating heavy fuel oil burner and on view was an Urquhart medium-pressure air-atomising burner fitted to a Beeston Brigadier boiler. The programme includes the establishment of the relationship between the Shell smoke number and the air fuel ratio and the effect on combustion of atomising air pressure and fuel temperature. Other points to be determined are the variation in fuel temperature at the atomiser, and the variation in Shell smoke number when starting in a hot or a cold combustion chamber, together with operation of the nozzle shut-off valve. Noise generated by domestic oil-burning installations is being evaluated in the laboratory and a demonstration showed the effect of fitting acoustic filters and baffles. The former was fitted to the draught stabilisers to eradicate low frequency noise, and the latter was mounted over the burner to absorb the high frequency noise generated by the fuel pump. Considerable improvement was noticeable, but since a reduction of not more than 5 dB was measured it was evident that reduction in annoyance is dependent upon the suppression of selected frequencies in the noise spectrum.

Since L.P.G. has been introduced in many areas overseas it is necessary that training in its use and handling is given. At Egham courses are arranged for this purpose and in the domestic demonstration laboratory are a number of installations which incorporate a wide variety of faults and on which trainees practise fault finding and corrections. Another aspect of training is that given to overseas members of the technical staff, and for this purpose there is a liquid fuels demonstration laboratory equipped with a variety of burners and other appliances. The combustion laboratory is also concerned with the development of oxypropane equipment and its use, and on view was a selection of oxypropane burners while demonstations showed bevel cutting of steel plate, flame washing of casting risers, and the use of a vacuum regulator system which makes it possible to use safely piped fuel gas in a shipyard.

During the tour a brief visit was paid to the test plant and the fully equipped workshops. In the main plant room are the electricity distribution board, fuel-oil circulating pumps and ring main oil heaters, and in an inner soundproofed room are the air compressors and fans. Central heating is maintained by two oil-fired boilers each of 1,750,000 B.Th.U. rating and fitted with a fully automatic preheating pressure jet burner. Test fuels are stored in six 1000-gallon tanks and three 275-gallon tanks. To dissipate the heat from the various test boilers and furnaces a closed water circulating system was adopted. The cooling water is pumped through an air-cooled heat exchanger, illustrated herewith, which is rated at 6,000,000 B.Th.U. per hour, and in which the water temperature is controlled automatically by means of three sets of louvres and three fans. These vary the airflow through the heat exchanger and provide more control stages, the louvres being opened one by one to provide degrees of natural draft cooling while the fans are progressively brought into use as the load increases.

Railway Accidents

THE annual report of the chief inspecting officer of railways for 1959 shows that during the twelve months under review only one passenger was killed in train accidents, as compared with eighteen in 1958 and ninety-two the year before. The number of passengers injured also decreased to 8044 as compared with 9041 the previous year. The thirty-four passengers killed as a result of movement accidents lost their lives mainly as a result of misadventure and carelessness when entering or leaving trains in motion, falling off platforms or out of carriages and opening or closing doors. On the other hand an increase is noted in fatal accidents to railway servants—161 killed and 14,408 injured as compared with 130 killed and 14,510 injured in 1958.

An interesting feature of the 1959 report is the inclusion, for the first time, of a series of graphs showing the trend in train accidents since 1946. One of these graphs shows the total fatalities in the working of the railways year by year since the war, and another illustrates how passenger fatalities in train accidents are largely fortuitous. For example, during the year under review a crowded express travelling at high speed was derailed at Slough, yet the passengers escaped virtually unhurt. On the other hand, the accidents at Harrow in 1952 and at St. John's, Lewisham, in 1957, accounted for nearly 40 per cent of the total since the war.

The graphs also show that since 1946 the fatality rate in train and movement accidents combined has been halved ; the incidence of collisions and derailments has dropped by one-third ; accidents caused by technical defects are just over one half ; and failures of rolling stock and permanent way are less than one-quarter of 1946.

A graph showing the trend of accidents caused by human error indicates that there has been a decline in the number of accidents resulting from the two most serious types of human error—signalmen's mistakes and drivers passing signals at danger. By contrast, accidents caused by other human failings—such as irregularities committed by enginemen and combined mistakes between enginemen, signalmen and other staff —have been increasing since the war, and last year were 13 per cent greater than the average for the first ten post-war years.

Occurrence of Sulphates in the Geological Succession

By E. M. HUGHES

Consulting engineers reporting on the foundations of a large hospital built about twenty years ago at Carshalton, Surrey, recently reported erosion by a sulphate chemical. The author of this article discusses the action of sulphates on concrete and their occurrence in geology.

Introduction

IF a structure on a concrete foundation begins to develop cracks, or to show other signs of differential movement some time after construction, the defects may be due to one of many causes. These include an increase in the stresses of the structure as a result of differential settlement; a deterioration of the concrete in the foundation; or the development of defects in the superstructure. The dangers of concrete disintegration are often ignored. When cracks first appear they are commonly ascribed to unequal settlement, and the real cause is not recognised until the deterioration has advanced so far that it can no longer fail to attract attention. The manifestations of concrete disintegration and the conditions leading to chemical attack must therefore deserve careful consideration. The two substances most commonly attacking concrete are sulphates and carbon dioxide. It is intended that sulphates shall be discussed here.

Effect of Sulphates on Concrete

Portland cement is composed of a number of compounds the reactions of which, with water, lead to the setting and hardening of the cement. Sulphate solutions react both with the free calcium hydroxide in a set cement to form calcium sulphate, and with the hydrated calcium aluminates to form the more insoluble calcium sulpho-aluminate. A typical reaction series is seen below with sodium sulphate attack:

(i) $Ca(OH)_2 + Na_2SO_4 . 10H_2O = CaSO_4 . 2H_2O + 2NaOH + 8H_2O$

(ii) $3CaO . Al_2O_3 . 12H_2O + 3(CaSO_4 . 2H_2O) + 13H_2O = 3CaO . Al_2O_3 . 3CaSO_4 . 31H_2O$

(iii) $2(3CaO . Al_2O_3 . 12H_2O) + 3(Na_2SO_4 . 10H_2O) = 3CaO . Al_2O_3 . 3CaSO_4 . 31H_2O + 2Al(OH)_3 + 6NaOH + 17H_2O$

This reaction will not proceed very far unless there is an excess of the sodium sulphate.

With calcium sulphate only, reaction (ii) occurs. Magnesium sulphate reacts more extensively with concrete and decomposes the hydrated calcium silicates in addition to reacting with the aluminates and calcium hydroxide. If tri- or di-calcium silicate is placed in a magnesium sulphate solution, formation of gypsum crystals occurs rapidly :

$3CaO . 2SiO_2 aq. + MgSO_4 . 7H_2O \rightarrow CaSO_4 . 2H_2O + Mg(OH)_2 + SiO_2 . aq.$

The attack of sulphates on concrete is accompanied by a marked expansion as a result of the growth of the newly-formed calcium sulpho-aluminate and gypsum crystals.

Factors Influencing Attack

The influence of soluble sulphates on concrete is related to various factors. The most important is probably the amount and nature of the salts present. The rate of attack depends on the rate of sulphate replenishment after the salt is removed from solution in the concrete.

The type and quality of the concrete and the form of construction have a marked bearing on the style of sulphate reaction. The reaction of soluble sulphates on the constituent minerals in the cement which is used will be accentuated by the porosity of the concrete. Concrete structures with a water-pressure one side will be more vulnerable to attack due to forces injecting the solutions into the material. Capillarity will also bring solutions into the concrete, particularly if one side is exposed to evaporation forces which will help precipitation. This effect is greater with sodium and magnesium salts than with calcium.

Sulphates occur as bedded deposits, partings or lenses in marls ; as vein ramifications or selenite crystals in stellate or single forms scattered through clays. Concrete is not attacked by these in the solid form but only by their solutions in water. The amount dissolved in ground-water varies with weather conditions and drainage of the clay. Whether or not the concrete structures will receive rapid attack of the foundations is dependent on the general level of the water-table, and its seasonal variation. Gypsum is only slightly soluble in water and amounts to 200 parts of calcium sulphate per 100,000, i.e. 120 parts of SO_3 per 100,000. Sodium and magnesium sulphates are very soluble in water, so that the amount of soluble sulphate present in the ground may be much greater.

Forms of Deposition in the Ground

The various sulphate salts that can cause deterioration of concrete are found in many different sub-soils but occur mainly in clays. The most important of these salts are gypsum (calcium sulphate), epsom salts (magnesium sulphate), and glauber's salts (sodium sulphate). The natural distribution of sulphates may be divided into two groups.

Those Formed as Primary Deposits.—This type of deposit is formed by evaporation of solutions containing sulphates. Evaporation and precipitation of sulphates can occur in many different environments.

(*a*) Waters responsible for springs gather materials in solution through the rocks in which they circulate. Calcium carbonate is the most abundant deposit laid down in this manner, but in some areas it is exceeded by sodium chloride or calcium sulphate. These deposits are rarely pure and the calcium sulphate occurs as gypsite. They have a limited extent and cover a maximum area of only a few acres.

(*b*) Lakes of high salinity will, when the rate of evaporation is great, precipitate calcium and magnesium carbonate followed by calcium sulphate and sodium chloride and the bitterns. The conditions most suitable are those of an inland sea or lake in semi-arid environments, where a supply of saline water continually replenishes the lake at a similar rate to the amount evaporated. A good example of this is seen at the present time in the Gulf of Kara Boghaz, where the sea-water is washed into the Gulf from the Caspian Sea. It has been estimated that some 350,000 tons of salt are being brought in daily. At the present time gypsum is being deposited in large amount adjacent to, and for some distance from, the mouth of the Gulf. The waters are saturated with sodium sulphate during the winter.

(*c*) Mechanical deposits of evaporites are mainly composed of calcium sulphate and consist of gypsum and anhydrite in a sand and gravel form. These have been derived from an older gypsum or anhydrite deposit or from efflorescences about springs or lakes.

Those Formed as Secondary Deposits.—Sulphuric acid is formed on oxidation and hydration of sulphides. If this acid flows over carbonates, reaction occurs and sulphates are formed. This is well seen in the London Clay where iron sulphide and fossil shell-beds have, by migratory fluids, produced gypsum.

Certain bacteria in the soil have the ability to oxidise organic sulphur compounds, sulphides and free sulphur to sulphuric acids or sulphates. These bacteria are aerobic, whose activity appears to be favoured by the presence of calcium carbonate.

General Distribution in the British Isles

A general study of the stratigraphy of the British Isles gives an indication of the likely periods during which sulphates may have been deposited.

Primary deposition of evaporites occurred during the Permo-Triassic era. In the Permian series, sulphates are associated with the Magnesian Limestones. In the Triassic, sulphates are associated with the Keuper Marls. In some localities, notably around Nottingham, barium sulphate forms the cement of the Bunter Sandstone, but this is relatively insoluble and therefore insignificant.

The Permian and Triassic deposits occur over a large area of Central England, the Cheshire Plain, along the east side of the Pennines to the north-east coast at Middlesbrough, and running south-west through Bristol to the south coast in the area of Exmouth. An outcrop, of wedge shape, skirts the north and east boundary of the Lake District. Outcrops occur along the coast of South Wales from Porthcawl eastwards; and along the coast of Western Ross and Cumberland ; and form a coastal strip from Liverpool to Fleetwood.

Sulphates occur in various localities where there are outcrops of Lower Lias and Oxford Clay. Potassium aluminium sulphate (alum) occurs in the Upper Lias in Yorkshire. Small arms of the sea were cut off in the Lower Purbeck times and, in these, beds of gypsum were deposited in the Isle of Purbeck.

Secondary deposition of sulphates is often widespread in clays which contain iron pyrites and fossil shells. Crystals of gypsum are frequently found in the Kimmeridge clay and Ampthill Clay in the Jurassic. The Gault Clay, at the base of the chalk, skirts the Weald and contains occasional gypsum crystals as also does the clay and marl series of the Oligocene—particularly the Bembridge Marls of the northern part of the Isle of Wight.

The London Clay is probably the best example of the secondary type of deposition, and forms a large basin. It underlies the London area and extends westwards to Newbury, eastwards along the north coast of Kent and north-east to Harwich. The outcrop covers parts of the counties of Berkshire, Buckinghamshire, Middlesex, Surrey, Essex and Kent. A smaller basin of London Clay underlies part of Hampshire. The gypsum is found in the clay as stellate groups and individual crystals.

A geological map of Britain shows the beds mentioned above, but within these

areas there has not been a uniform deposition through the series of one period. Some parts may be completely devoid of deleterious material, whereas others may have up to 90 per cent of sulphate material—particularly in the areas south of Derby, around Nottingham and Newark.

Boulder Clay often acts as a seal on the sulphate bearing beds and similarly river gravels may conceal the presence of sulphate strata below.

Conclusions

Chemical testing for the presence of sulphates must be an essential feature of a site-investigation within the outcrop areas of the rocks and soils mentioned. These can be found on a geological map of the area concerned. Transportation of sulphate-bearing drift may have taken place in superficial deposits and should automatically be tested for where the site lies near to the suspect periods.

Any other sites would need to be investigated for the presence of sulphates if covered by a fill, the origin of which appears to have been from the contaminated areas. At sites in St. Helens and Sunderland a burnt shale fill was used and gave strong sulphate reactions although the sites were not lying within naturally occurring sulphate areas. Artificial slags and fills must be treated individually and inquiries made as to their origin and the processes through which they have passed.

Other localities which require close inspection of the soil are those where conditions are present for eventual production of sulphates from material at present not in sulphate form, for example, peat deposits which are interbedded with porous layers containing iron sulphide. These will allow free movement of solutions and production of mobile weak solutions of sulphuric acid. These types of deposit, however, are comparatively recent in age, and would usually be insufficiently consolidated to accept large structures sited on them unless piled.

Expansion of Rogerstone Aluminium Strip Mill

No. II—(*Concluded from page* 638, *October* 14)

When the continuous aluminium strip mill was installed at Rogerstone in 1949/50, *provision was made for considerable expansion. New plant has now been installed which not only enables the strip output to be increased, but also makes available rolled plate in much greater widths than hitherto obtainable*

Re-Planned Hot Line

WHEN the 144in mill is working in conjunction with the hot line, the existing 96in mill acts in an intermediate capacity. On the occasions when the hot line is operating independently of the 144in mill, the 96in mill acts as the breakdown mill, takes three to five extra passes and delivers slabs direct to the hot-finishing mill. The 96in mill, when acting as an intermediate, handles far longer slabs than it was designed for. To assist the existing side guides in squaring up the slab, those associated with a former 84in mill are to be relocated outside the existing guides. This stand will then be equipped with the full range of turning, centering and guiding equipment appropriate to a stand which has to break down ingots and also roll slabs in long lengths.

The up-cut shear and edge trimmer, positioned immediately in front of the 88in finishing mill, will be moved to take the place of the 84in mill. This shear can handle 1in thick hot aluminium plate up to 80in wide and is driven by a 50 h.p. continuously-rated motor. Off-cuts from the shear fall down a chute to a conveyor, which lifts and deposits them in scrap bins at floor level. The shear is provided with side-guiding equipment on the entry side to deal with long slabs. The modernised edge trimmer can cut strip 0·6in thick and up to 72in wide. It is driven by a 120 h.p. motor, which is controlled to synchronise the cutter speed with that of the table. In its new position it will edge trim slabs up to 200ft long without interfering with other operations in the line.

A new stand (Fig. 8) has been set in front of the two existing stands on foundations laid down when the line was built. It was made by W. H. A. Robertson and Co., Ltd., Bedford, and is an 88in, four-high non-reversing stand, with 24in diameter work rolls and 56in diameter back-up rolls. The centres of the rolls are 19ft in front of the centre of the following mill. The mill housings are made of cast steel and weigh 90 tons. Roll journal bearings are of the Robertson flood-lubricated pattern, consisting of white metal sleeves which are mounted in cast steel chocks, and located axially by ball races. The work-roll chocks are held between horns on the back-up roll chocks by wedges, which can be used to offset the work rolls by as much as $\frac{3}{8}$in. The rolls are of forged steel, 70° Shore hardness on the work rolls and 50°/55° Shore hardness on the back-up rolls. The screw-down system is driven at 0·25in per minute by two 50 h.p. d.c. motors through worm reduction gears. A magnetic clutch, linking the drives, is released for differential adjustment. The maximum gap obtainable between work rolls is 6in.

The new stand is driven, at 150/300 r.p.m., through a gearbox made by David Brown Industries, Ltd., Huddersfield, by a 4000 h.p. A.E.I. single-armature d.c. motor and is coupled to a 1 to 1 pinion box by a Holset coupling. Gearbox reduction is 3·75 to 1.

The centre stand, originally the entry stand, was powered by a 3000 h.p. motor through a slab coupling and 60in face pinions; the motor has been replaced by a second 4000 h.p. A.E.I. single-armature d.c. motor, operating at 58/116 r.p.m., with a direct drive to the mill pinion box. The 2600 h.p. motor on the exit stand, driving an existing gearbox and 1 to 1 pinion stand, is retained.

The roll coolant, lubrication and fume-extraction equipment of the original line have been modified where necessary to suit the new three-stand arrangement, and the mill can now roll hard and soft alloys at speeds up to 800ft per minute. Strips can be rolled to any gauge between 0·080in and 0·25in, and coiled.

In the rolling sequence of the original hot line, the 88in mill was followed by a 651ft table fitted with cooling sprays to reduce the strip to a temperature at which it could be satisfactorily coiled. At the end of the table the strip was edge-trimmed and then up-coiled. Developments in hot coiling since the mill was first laid down have made it possible to coil strip satisfactorily without first having to cool it. New edge trimming and coiling equipment has therefore been fitted immediately following the last stand of the finishing mill.

The edge trimmer, made by Stamco, can accept strip at 200 deg. Cent. to 300 deg. Cent., in both common and strong alloys, between 24in and 80in wide. Strip up to 0·25in thick can be handled, trimming speeds varying between 800 and 450ft per minute according to gauge. The pinch rolls and cutters are driven by a 150 h.p. motor, the drive being

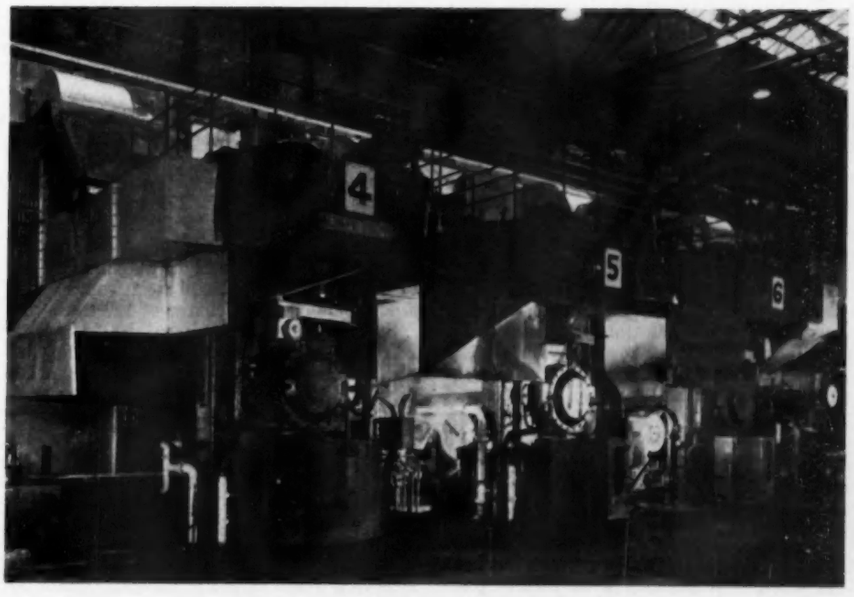


Fig. 8—Hot line modified by the addition of a new 88in stand

synchronised with the mill speed. Scrap is cut to manageable lengths by another cutter, raised by a conveyor system under the tables and deposited in scrap bins at floor level.

The centre-line of the reel of the Davy and United down-coiler (Fig. 9), is set 25ft 6in from the last stand of the 88in mill. It has a two-speed gearbox and will coil strip between 0·080in and 0·25in thick, 28in to 80in wide and at temperatures between 200 deg. and 300 deg. Cent. at 450ft or 800ft per minute matching the speed of the edge trimmer. The coils, which have an inside diameter of 24in, are limited to outside diameters of between 32in and 54in and a maximum weight of 9000 lb.

Strip emerging from the edge trimmer is caught between pinch rolls, which divert it to the coiling reel. The upper pinch roll, 24in diameter, is driven through a 4·08 to 1 gear ; the lower roll, 16in diameter, through a 2·86 to 1 gear. Common to both pinch rolls is a 35 h.p. motor. The strip is directed round the reel by a belt wrapper which is retained until there are sufficient turns to hold the rolling tension. The tension range of coiling through the gearbox varies from 9000 lb to 48,000 lb, for speeds of up to 450ft per minute, to 0 lb to 9000 lb for speeds of 450ft to 800ft per minute. The reel, which is of the four-segment, collapsing type, concentric when open, is driven through a two-speed gearbox by a 400 h.p. A.E.I. motor with a speed range of 375 to 1100 r.p.m. On completion of coiling, the coils are removed from the collapsed mandrel by a hydraulically-operated stripper car to a conveyor. They are weighed while on the conveyor and are eventually lifted by crane and placed in a storage bay to cool.

Additional equipment has also been installed in the cold mill, and further annealing facilities to meet the need for greater quantities of alloys, have been provided.

Cold rolling facilities are to be improved by modernising the two-stand 72in tandem mill, situated in the East Works at Rogerstone, and relocating it in an extension of the cold bay. This is a Robertson two-stand, four-high, non-reversing mill with rolls of 15in and 37in diameter. When the work on the mill is completed, it will be able to roll coils of heavier-gauge metal at greatly increased speeds.

Modernisation of this mill is being carried out in four stages. The first, which has been completed with the mill in its present position, involved improvements to the roll coolant system to maintain a high standard of surface finish, and new feed arrangements, enabling the mill to handle coils down to 0·016in entry gauge, as compared with the original minimum of 0·050in.

The mill will be moved to the new cold mill building in January, 1961, and will be fitted with new motors in the second stage of modernisation. These motors, of 2200 h.p., will be fitted to each stand with new pinion stands, new bearings, and reel and belt wrapping equipment. When this stage is completed the mill will be capable of rolling at 2500ft per minute compared with its present speed of 360ft per minute. The two final stages cover the full mechanisation of handling equipment and installation of control refinements, and of two further 2200 h.p. motors, linked in tandem, giving a 4400 h.p. drive to each stand and consequently greater torque for rolling thicker gauges.

The greater amount of strong alloy in the increased output of the mill has required a more than proportional increase in annealing capacity. To this end, existing gas and electric furnaces have been augmented by two new Stein and Atkinson oil-fired coil-annealing furnaces, with controlled-atmosphere plants. They are located in an annexe to the new cold bay building. The furnace and furnace-door construction is a steel shell, lined with heat-resisting alloy plates and "Stillite" insulation. The door is counterbalanced to assist the raising and lowering winch and, when closed, is pressed by hydraulic pushers against a seal of water-cooled sponge strip insert. Each furnace has a clear load space of 2230 square feet, is 27ft long by 10ft high by 8ft 3in wide, and can accept sixteen coils of 46in outside diameter stacked 70in high, weighing a total of 67 tons. Different coil sizes would allow a possible maximum charge of 112 tons.

Special burners, developed by Stein and Atkinson, Ltd., in conjunction with the Surface Combustion Corporation, use marine diesel oil to heat high-quality stainless steel radiant tubes fitted in the sides of the furnace and insulated from the furnace interior. Air is drawn over banks of these tubes by water-cooled recirculating fans, supplied by Keith Blackman, Ltd., and is then ejected at the base of the furnace sides into plenum chamber zones, which may be separately controlled, and which are a part of the annealing tray. The hot air then passes up through the load and is recirculated by the fans. The fans, driven by 40 h.p. motors at 1480 r.p.m., develop 1½in water gauge, giving a delivery of 30,000 cubic feet per minute at 600 deg. Cent. The furnaces have an operational heating range from 150 deg. to 600 deg. Cent. and can hold a selected temperature within that range of ±3 deg. Cent. They operate nominally on a twelve-hour cycle per load which gives an annual throughput of between 24,000 and 30,000 tons.

Electricity Supply and Distribution

At the end of the war the Rogerstone plant was fed at 11,000V through two 100MVA ring systems connected to the supply authorities' mains by reactors. When the continuous strip mill was laid down in 1949 and 1950, the increased size of unit loads made it necessary to reorganise the supply system completely, and 66kV feeders were brought to a new main substation on the site. These were connected, *via* outdoor duplicate busbars and air-blast switchgear, to two 20MVA and one 15MVA 66kv/11kV transformers, the secondary sides of which fed a new duplicate-busbar 250MVA switchboard. This switchboard was used to supply the existing ring systems, plus new substations, by means of radial feeders. Spare feeders were installed in case of breakdown.

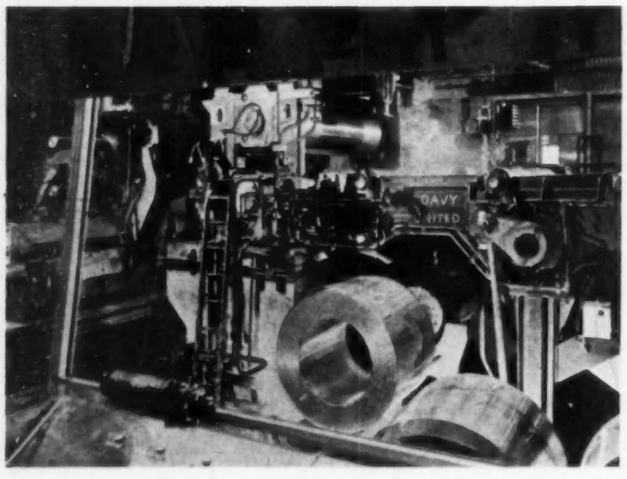


Fig. 9—New hot down-coiler on hot line

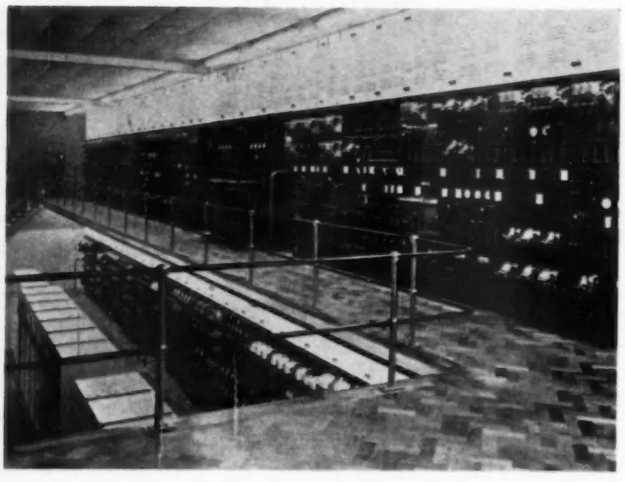


Fig. 10—Switch and control board for 144in mill

During the current scheme the practice has been to move and re-group existing substations rather than to create more new ones. Permanent substations have been built in those areas where future requirements have been definitely decided, but in other areas temporary ones have been set up to give flexibility to future expansion schemes at present only broadly planned.

The 144in mill has an installed load of approximately 12,000 h.p. This includes the two 4000 h.p. motors for the mill drive, supplied by an 8000 h.p. flywheel motor-generator set ; and two 1000 h.p. motor-generator sets—one to provide power for mill screwdowns and various auxiliaries, and the other to supply a slab shear and a considerable amount of pumping and other equipment used for the mill roll coolant system, lubrication and hydraulic purposes. The two 1000 h.p. motor-generator sets are driven by synchronous motors, which provide the power-factor correction required by this section of the plant.

To provide electricity supplies, an existing substation has been moved to a new position in the mill motor-room basement, where the

11,000V switchboard, made by A.E.I. Switchgear Division, has been extended by the addition of new panels (Fig. 10). The existing 0·4 square inch feeders were extended and a third feeder in aluminium-sheathed paper cable was run.

The large motor-generator sets are supplied at 11,000V. The 400V circuits in the mill area are connected to an open-type panel about 100ft long, divided into two sections. These are coupled by means of three oil-circuit-breaker switches of 1200A capacity, one acting as bus section switch, the others receiving the incoming cables from two 750kVA Crompton transformers. From this substation, 11,000V cables run to two subsidiary substations, one to provide power for the auxiliaries on four oil-fired pit-type pre-heating furnaces, and the other to provide power for the pumphouse that supplies and treats the roll coolant for the mill.

The cables in each case connect directly to Crompton 750kVA transformers, which supply local switchboards of various types made by The English Electric Company, Ltd. There is a combination fuse-switchboard for furnace auxiliaries, and, for the pumphouse, a " Superform " switchboard which has built into it an incoming air circuit-breaker, motor starters up to 120 h.p., switchgear for 100kW immersion heaters and various fuseboards. The contactors were made by the Donovan Electrical Company, Ltd.

The auxiliary equipment on the pre-heating furnaces comprises four 75 h.p. and four 35 h.p. motors, together with various control auxiliaries. The contactor panel for each furnace was supplied by the Donovan Electrical Company, Ltd.

An additional stand has been added to the existing 88in hot-finishing stands in the hot line sequence, and all three are now powered by means of a modern rectifier system. The mill motors are rated at 4000 h.p., 4000 h.p. and 2600 h.p. respectively, and are supplied from a relocated substation *via* grid-controlled rectifiers and transformers.

The A.E.I. 11,000V switchboard supplies, in addition to the mill motors, a 1000 h.p. synchronous motor-generator set which provides power for the down-coilers located immediately after the mill, and gives the power-factor correction required at this substation. As in the case of the 144in mill, 400V auxiliaries are controlled by an A.E.I. open-type panel which is supplied through a 750kVA Crompton transformer.

The cold-finishing facilities have been expanded by the installation of two oil-fired annealing furnaces, a high-speed slitting machine, and handling equipment with the capacity to handle the increased coil size of up to 9000 lb. The new furnaces each have eight 55 h.p. fans and various other motor loads controlled by Brookhirst Igranic contactor panels, and these and the other loads are mainly supplied from an English Electric " Superform " 400V switchboard, which has two incoming air-circuit-breakers and also incorporates various fuse-boards and other circuits. The switchboard is fed through two 750kVA Crompton transformers, which are connected direct to an existing substation some distance away. As in other such cases, inter-tripping of h.t. and l.t. switches is provided for, and remote 11,000V trip buttons are fitted on the 400V switchboard.

In a further extension to the cold mill, an existing 72in two-stand tandem cold-finishing mill will be installed with new driving motors, to give increased power and speed. These motors, of 2200 h.p., will be supplied from the existing motor-generator sets previously used for the 88in mills, which have now been changed to rectifier drives. At a later date a further two motors of 2200 h.p. may be added in tandem, to make up the total ultimate power of 4400 h.p. envisaged for each stand of the 72in mill. A new substation is being built for this mill, and it will be supplied from the main substation through two new 0·4 square inch feeder cables. The mill 400V auxiliaries will be controlled by means of a cubicle-type switchboard of English Electric manufacture, and as before, this will be supplied from a 750kVA transformer.

The two work rolls of the 144in mill are independently driven by a " top forward " arrangement of 4000 h.p., single-armature, a.c. motors which are supplied from an Ilgner set, each motor being in series with two 1620kW, 475V generators. The generators are driven at 750 r.p.m. by an 8000 h.p., 11,000V slip-ring induction motor mounted on the same shaft ; a 200,000 h.p. per second flywheel supplies energy for peak loads. The release of energy from the flywheel is regulated in accordance with the load by means of an automatically-controlled slip regulator in the rotor circuit of the induction motor. This regulator also acts as a motor starter for the Ilgner set. Braking of the slip-ring motor is achieved by injecting d.c. into the stator.

The main motors and their supply generators, together with the exciter motor-generator set and mercury-arc rectifiers, are arranged in a motor room (Fig. 11). Adjacent to this is a control room housing the auxiliary a.c. motor controls and the main d.c. contactors, with magnetic amplifiers, rectifier phase-shifting amplifiers, and the alarm annunciation equipment ; there is also a supervisory control desk. All the control gear is separated and sealed from the rotating equipment by a double-glazed screen. Below the plant room and the control room are arranged the main control resistors, rectifier reversing switches, lubrication services for the main machines, and individual ventilation fans for the mill motors and Ilgner sets.

The motor control is by a closed-loop system. A voltage control system, operating on armature voltage, is used with constant field up to a base speed of 30 r.p.m. Thereafter speed increases, up to a top speed of 60 r.p.m., are effected by field weakening, using a closed-loop voltage control of the motor field excitation. Both the armature and field controls have armature-current-limiting features, and employ magnetic and rotating power amplifiers. The two motors are made to share the total load by a magnetic amplifier load-balance circuit operating on the field of the four main generators. The total load can be proportioned between each motor, to control the turning up or down of the aluminium slab being rolled by the mill.

The mill operator controls the mill speed through a lever-operated rheostat on the main control desk. This desk has instruments indicating speed and individual mill motor loadings, as well as a number of pre-selecting control rheostats and switches. Control of some mill tables can be transferred to local desks ; an annunciation board in the main cabin indicates the selection.

The two 200/400 h.p., 420/840 r.p.m., 230/460V motors that drive the screws are constant-field, Ward-Leonard controlled machines and are fed individually from 320kW, 400V generators. The control system used is a closed-circuit voltage control with magnetic amplifiers. Current-limiting features are incorporated so that the maximum torque that may be exerted by the screw motors is, at all times, controlled by current-limited feed-backs to the screw generator magnetic amplifiers.

Operation of the screws is effected by a common control level on the left-hand side of the mill control desk, and both coarse and fine positional indicators are provided for both screws on large-diameter indicator dials. These are positioned, together with a screw-pressure indicator, in a low-level console unit in front of the control desk.

The screwdown system has two speeds : the first, 25in/50in per minute is for screwdown adjustment when roughing and finishing ; the second, ½in/1in per minute, is for screwdown adjustment under load. The design of the screwdown generator and control equipment is such that the slower speed can be linked to the gamma-ray thickness gauge, already fitted, to give a completely automatic gauge control.

The rollers of the mill tables are driven in sections by 75/150 h.p., 515/1030 r.p.m., 230V/460V motors, fed in banks from pairs of grid-controlled mercury-arc rectifiers. The controls are essentially closed-loop voltage

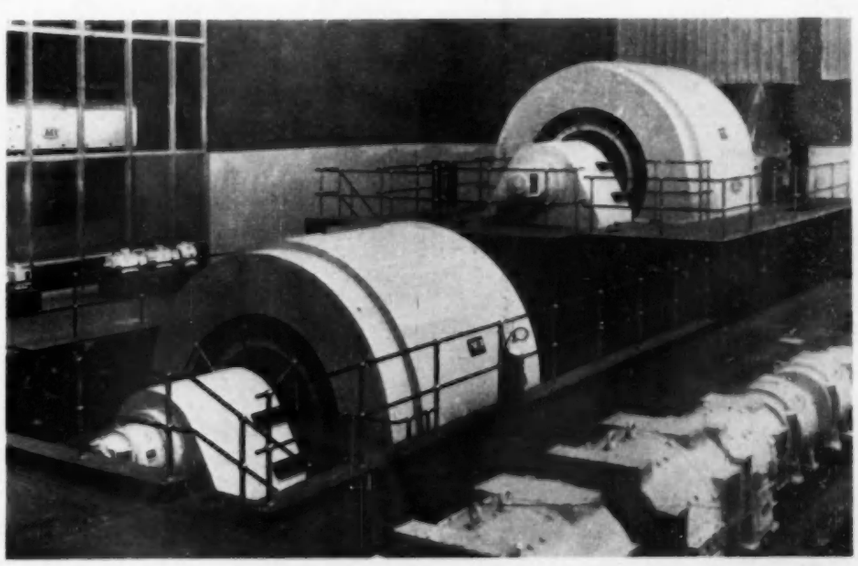


Fig. 11—Main drive motors for 144in mill

and current limiting systems, and synchronise the table speed to the mill speed by a tachometer-generator reference from the mill motor. The provision of bus voltage-reversing switches, which can operate only at zero current, together with suitable control gear, enables the rectifiers to be used as inverters, accepting power from the motors and returning it to the supply. Alternative control is available for certain sections of table, and by operation of a switch on the mill control desk, the slab shear operator can be given control of a section.

The entry and exit turntables are each powered by two 75/150 h.p., 515/1030 r.p.m., 230V/460V motors, which are supplied from mercury-arc rectifiers. The forward and reverse control is through magnetic amplifiers, in a similar manner to the other tables. Boosters are also provided and are used for turning the ingot, and turning is obtained by variation of the booster voltage. The turning control is a lever-operated potentiometer situated by the mill operator's right hand.

The slab shear is driven through a reduction gearbox by two cross-compensated 400 h.p., 1000 r.p.m., 440V, low-inertia motors which are fed from a single 640kW, 440V Ward-Leonard generator, controlled through magnetic and rotating amplifiers. This system provides current-forcing and current-limiting features. Shearing action is initiated by a master switch in the control cabin, and shearing, once commenced, continues to the end of its cycle and is stopped by a cam-driven limit switch. Facilities are also available for inching the shear blade.

The three stands of the 88in mill are powered by separate motors. The first and second have new motors of 4000 h.p., 675V, whilst the outgoing stand retains its 2600 h.p., 202/404 r.p.m., 440V motor. The top and bottom work rolls on each stand are driven by a 1 to 1 pinion gearbox, and whilst the intermediate-stand motors have a direct drive on to the pinion box, the first and last-stand motors have reduction gearing interposed between the motors and the gearboxes.

The control consists of uni-directional closed-loop speed controls, the power being supplied by separate banks of grid-controlled mercury-arc rectifiers for each stand. Speed variations, up to base speed, are effected by variation of the rectifier output and thereafter, up to twice base speed, by field weakening. "Coarse speed" selection is switch-controlled by the mill operator, who is also provided with a "fine speed" lever-operated potentiometer control for each stand. The control system is sufficiently "stiff" to maintain the actual mill speed to with $\pm\frac{1}{4}$ per cent of the selected speed over the range of 60 to 200 per cent of base speed.

The screwdowns are Ward-Leonard controlled. Duplicate master-control switches are available at the individual control cabinets on the side of the mill stands, as well as in the control cabin.

The choice of rectifiers for the supply of the mill motors was governed by the necessity for providing equipment that could be built into the limited space available, whilst at the same time making provision for a possible future fourth stand. The use of rectifiers was an ideal choice owing to the smaller area required when compared with m.g. sets of equal output. Furthermore, the additional power requirements were in this way obtainable without the further increase in fault capacity inherent in the use of additional m.g. sets driven by synchronous machines.

The alterations involved an almost complete change of control equipment and, since this could not be fitted into the old control cabin, connected, and tested during the normal shut-down period, a new control cabin was installed. It was temporarily placed behind the old cabin while the controls were installed and wired to the new control equipment. During the shut-down the old cabin was replaced by the already-wired new one.

Whilst provision has been made for two hot down-coilers, only one has been installed under the present development. This coiler is driven through a reduction gearbox, having alternative ratios of 7·7 to 1 and 13·7 to 1, by either one or two 400 h.p., 375/1100 r.p.m. motors, depending on whether high tension (9000 lb to 48,000 lb) or low tension (0 lb to 9000 lb) is required. The control is by the Ward-Leonard system, both motors being provided with a generator.

The selected tension is set by the coiler operator and is automatically maintained by a closed-loop compensated current control, using two-stage magnetic amplifiers. Coil speed is determined by a tachometer fitted on the last stand of the 88in mill. The coiler auxiliary controls are housed in a control cabin local to the equipment. This cabin has been designed and positioned to give the operator maximum visibility for all operations.

Transformer Design and Testing

A new transformer factory has been opened at Stafford by The English Electric Company, Ltd., for building and testing the largest units practicable within the limitations imposed by transport facilities. A symposium held at the works last week described the equipment of the works and the constructional practices and research experience embodied in its products.

PAPERS on various aspects of the construction, design and testing of large transformers were presented at a symposium held in the new transformer works of The English Electric Company, Ltd., at Stafford, on October 13. The new works itself reflects the influence of the increasing size and weight of transformers, for it has been planned to overcome limitations on lifting capacity in the previous premises. Lifting large units had involved removal of oil and bushings, followed by their replacement, and it was decided that it had become necessary in the interests of uninterrupted production to pick up very large transformers complete with bushings and oil. In the new building 400 tons can be lifted through 60ft, and so a production line has been achieved which will not be held up because of inability to "leap-frog" transformers over each other. Heavy fabrication has been left in the old works. Metal cutting in the new works is confined to a splitting operation for the core steel. Tap-changer parts are made in these premises, but this section is completely isolated by barriers to keep in swarf. Overall area of the new works is 245,000 square feet and the building consists of six 580ft bays. Two 200-ton cranes are installed for lifting. Fig. 1 is a view in the works looking towards the three permanent building sites in the impulse testing area and the new impulse generator itself. The design and layout of the transformer works are described in detail in a paper contributed to the symposium by Mr. A. R. Kevan.

A four-floor, 40,000 square feet office block has also been built. For quick access to all files, the filing department is centrally situated and can be reached from all floors by a continuously running "Paternoster" lift.

Symposium Papers

The symposium proceedings opened with a paper by Mr. H. H. Begent and Mr. A. R. Kevan on "Future Trends." It was shown that the weights of the largest units required during the next decade will in most cases

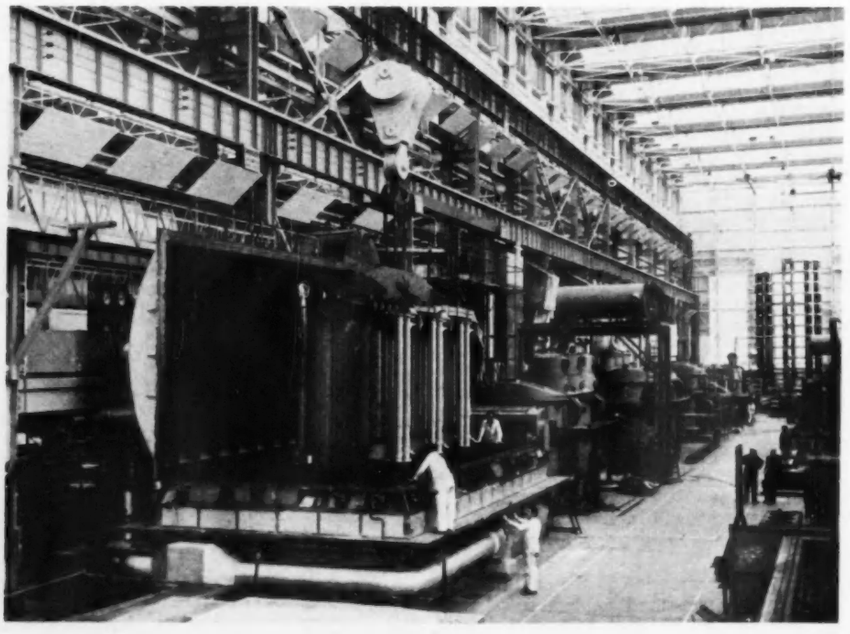


Fig. 1—Interior of new transformer works at Stafford, looking past one of the vacuum ovens towards the erection bay and impulse generator

exceed 200 tons, which in general is the limit imposed by bridges, dock cranes and vehicle capacity. Combination of high flux density (18 kg) high current density (4000A per square inch) and the lightweight tank might result in 15 per cent reduction in weight. This would give a transport weight for a 450MVA 300kV generator transformer within 200 tons but the unit would be uneconomic. A different approach, involving some form of subdivision is therefore necessary, alternatives being :

(1) Utilisation of three-phase groups of single-phase transformers.

(2) Three-phase units with core building and winding assembly undertaken on site.

(3) Subdivisible three-phase units.

Manufacture of subdivisible three-phase units offers the best solution from all aspects. The convenient design for subdivision has a five-limb core as in this transformer the yoke is half the sectional area of the yoke in a three-limb design. The proposed subdivision would be between phases in a vertical plane involving a break in the yokes, tank and tapping leads if a three-phase on-load tap-changer is used. Yoke joints may be butt or interleaved. Tests on a one-third scale model have shown the butt joints to be free of major problems. Such a unit has the advantage of being completely factory built and fully tested at only slightly increased cost and total weight and therefore from the weight aspect solves all problems up to the extremely large, very high-voltage units. Unfortunately, this construction, in common with single-phase units, does not solve loading gauge problems.

A major factor in these very large transformers, regardless of their transport weight, is short-circuit electro-mechanical strength. An opportunity has arisen to examine in detail the h.v. and l.v. windings of a 154/13·8kV 200MVA transformer after it had been subjected to three short circuits on the l.v. busbars. The fault current in the l.v. winding was calculated at 114,000 peak amperes. There was no visible sign of any movement of the h.v. or l.v. winding. This transformer employed spiral disc windings on the l.v. and intereleaved disc windings on the h.v. with solid fullerboard insulation between them. The type of winding and the major insulation used are regarded as major factors providing the required mechanical strength. Investigations show :

(1) Adequate mechanical strength is more easily built into disc windings than layer windings ; and

(2) Solid insulation has a mechanical strength superior to barrier insulation comprising concentric tubes of fullerboard.

Two papers were presented on applications of computers in transformer design and testing. A contribution by I. F. Beck and R. Hamilton described the writing of a programme to design the core and windings of a transformer to a given specification.

The design method employed is one of trial and error. The programme first assumes a typical value for several basic design constants, such as copper space factor and ratio of total load loss to I^2R losses. These constants are used in fundamental equations, which relate design characteristics to core flux density and overall winding dimensions. When solved these equations provide a trial value for flux density and overall core and winding dimensions and using these, a detailed design is completed and all performance details calculated. This first design will probably not meet the required performance but, using simple formulae, it enables the basic constants to be modified and the process repeated to produce a second design. This process is iterated as many times as is necessary until a satisfactory design is obtained.

The programme is simple to use and requires no knowledge of computers on the part of the designer, who need only furnish the basic specification of the transformer to be designed plus some constructional and major insulation details. The input specification is punched out on cards by the computer operator. The programme is read into the machine (" Deuce ") followed by the input data. The machine calculation takes about one minute before the completed design is punched out on cards, which are then transferred to a tabulating machine to enable the design to be translated to a form acceptable to the designer. The overall time taken is quite short and a batch of, say, ten designs may be completely processed within half an hour.

The quality of the design is excellent for inquiry purposes and the programme can be especially useful when it is required to ascertain the most economic design to meet a customer's capitalisation formula as a large number of designs with different loss levels can be easily and quickly prepared. The computer can also be of great assistance to the development engineer who frequently wishes to assess the effect of varying one parameter on a range of designs.

With the availability of larger computers and improvements in programming techniques, future programmes will be more comprehensive. For example, the computer, when presented with a capitalisation formula, will automatically produce the most economic design. Tank and cooling details will be provided for.

A second paper on computer applications, by R. Zambardino and K. Holland, dealt with the study of impulse voltage problems in transformers. Full mathematical treatment of the response of transformers to impulse is very involved and quite unmanageable without the use of digital computers. In addition to complex programmes used as a development tool, simplified programmes covering a wide range of impulse problems have been prepared for use by the designer as a routine tool. As an example, one programme calculates the initial voltage distribution in two windings of a transformer at the instant of impact of the front of the impulse voltage wave on the terminal. The maximum voltage gradient in the winding appears in this initial distribution, which consequently determines the axial insulation required to withstand full waves. If interleaved windings are used they will behave in a non-oscillatory manner and chopped waves do not produce higher stresses than full waves. Consequently for interleaved windings, all the insulation characteristics can be determined by this initial distribution.

If one winding only is considered, the calculations in the case of interleaved windings are often quite easy and can be speedily done by hand. When no electrostatic shield is used between windings, it is however very important to determine the initial distribution of the voltage transferred to the secondary. The total time taken by this " Deuce " programme for carrying out the calculation and punching of the results is about forty seconds. It is consequently possible to perform these calculations for a large range of alternative insulation arrangements from which the designer can select at a glance the most suitable.

The test plant in the new works was described in a paper by S. Chilton and B. Bates. Installed plant capacity is sufficient for the complete testing, including a full-scale heat run, of a 600MVA transformer. Four 10MVA d.c. motor-driven alternators combined with 42MVAR of capacitors represent the bulk of the test supply. Two smaller machines totalling 1000kVA capacity provide a variable frequency auxiliary system and a third set rated at 7·5MVA is used for over-

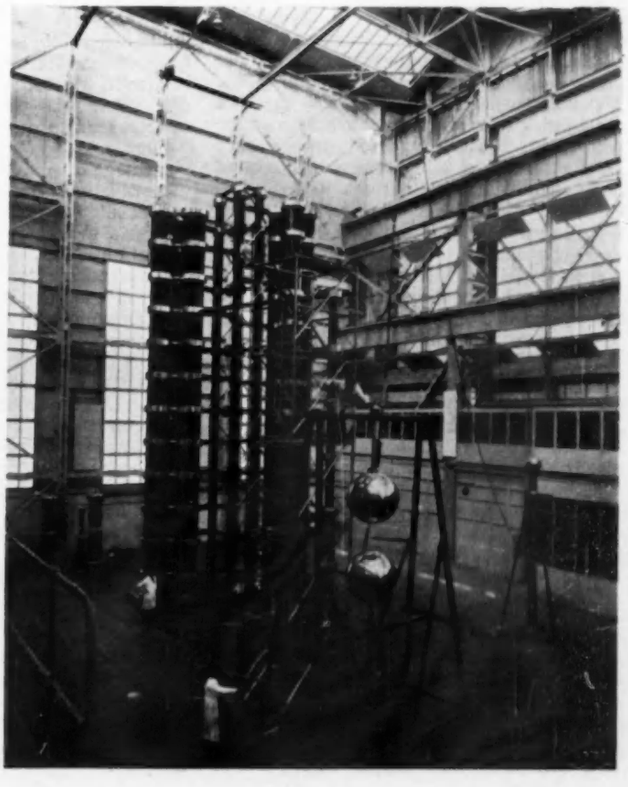


Fig. 2—Twelve-stage, 4·8MV impulse generator designed and built by the staff of the Stafford works for testing the highest-voltage and largest-capacity transformers at present contemplated

potential testing at frequencies between 100 and 200 c/s.

One of the 10MVA alternators mentioned previously may be synchronised to the incoming 11kV supply to provide variable d.c. for reactor testing. A range of testing transformers allows the selection of any voltage between 11kV and 80kV in steps of approximately 1kV.

Testing carried out at shop floor level is marshalled from control galleries overlooking the test area. A radio link between the various members of a team ensures that all tests are completed without inconvenience and unnecessary delay.

A new impulse generator (Fig. 2) has been designed and built at Stafford by the company's staff to test the highest voltage and largest capacity transformers envisaged for the foreseeable future. It was described in a paper by L. Wardle and B. Bates. The plant comprises twelve stages at 400kV per stage, giving a peak voltage of 4800kV. A 400kV charging voltage introduces the problem of corona discharge and random flashover, emphasising the importance of the correct choice of spark-gap. Exhaustive works tests have proved that the uniform-field type of gap showed the best overall features and, despite its expense, this was adopted.

In order to test low impedance windings it is essential that the generator has maximum capacitance. Each of the twelve stages has an individual capacitance of 0·36 microfarads made up of three 0·12 microfarad condensers in parallel, achieving the extremely high energy rating for the generator of 346kW-seconds.

The charging equipment comprises a transformer feeding a voltage doubling circuit using silicon rectifiers, controlled by a magnetic amplifier with a feed-back circuit from a resistance divider on the 400kV line. A current reference is taken from a potentiometer on the control desk to the magnetic amplifier, allowing the generator to charge until the feed-back current balances the reference, at which point the voltage stabilises.

In the course of a paper on " Some Factors in Transformer Design," D. H. Ryder and J. F. Tulk referred to improvement in losses obtained by clamping the limbs of medium cores without the use of through bolts. The company uses two methods, firstly a close-fitting tube of polyester resin glass tape which is subsequently cured in position ; and, secondly, a direct epoxy resin bond between individual laminations.

Windings and insulation were dealt with in a paper by J. B. Price and J. F. Tulk. They described the use of a terylene material named " Melinex " as a new insulant which possesses a higher breakdown strength than oil-impregnated paper, with an equal dielectric constant, while being impervious to moisture. A patented method of using " Melinex " in combination with paper has been developed by the company to allow penetration of oil into the paper although the oil cannot penetrate the " Melinex." They also described the reinforcement of solid fullerboard insulation on transformers above 110kV by additional wrapping of each interleaved h.v. disc coil with layers of paper, part of which is later cut away to allow free oil circulation (Fig. 3).

Tap-changing was the subject of papers by H. E. Pettitt, G. W. Sampson, and G. G. Wightman, the first dealing with tapping windings, and the second describing some characteristics of the latest design of English Electric tap-changer.

A paper on transformer noise by J. Wilkins and J. E. Lambert described an experimental steel enclosure which has proved effective in reducing noise from a 60MVA transformer by some 22dB. The steel plates, top and sides, forming the enclosure are supported from the transformer tank by special resilient brackets, and their construction is such that their natural vibrations are below audible range.

Discussing oil preservation systems, a paper by T. D. Desbrulais and A. E. Brierley

Fig. 3—Cutting out castellations in an interleaved coil to allow free oil circulation

compared the conservator and gas cushion methods and concluded that the conservator system was to be preferred. One of the drawbacks seen in the gas cushion is that the combined effect of oil temperature and nitrogen pressure lead to absorption of nitrogen in the oil. With a reduction of load the oil temperature falls, the oil level is lowered and the oil is left in a super-saturated state. Under these new conditions the oil cannot hold the same quantity of nitrogen, which is released from the oil. This release is in the form of bubbles of gas which lodge in the insulation structure and can give rise to local discharges. At points of electrical stress bubbles are also known to appear.

Even a " dry " transformer contains a percentage of moisture evenly distributed in the insulation. In its distributed state it is harmless. An increase in oil temperature increases the water vapour pressure in the insulation. There is a transfer of moisture to the oil and in turn from the oil to the gas space as a continual migration until a state of equilibrium is reached. The dew point in the gas space is thus reduced. Any sudden cooling of the tank cover results in condensation and free water is produced in droplet form. This concentration of free water on the windings causes breakdown. Experiments have conclusively proved this.

A paper on distribution transformers was presented by Mr. A. J. Millar. Developments in this field have been concerned mainly with the core and the windings. The use of an un-cut wound core of grain-oriented steel has reduced the iron loss in the smallest distribution transformers to less than one-third the value previously prevailing. In windings, the major development has been the use of synthetic-enamel-covered wire for h.v. coils. One advantage of this is that long layers can be used because of the accurate control of overall diameter, and in general, for 11kV, a coil in only two sections can be adopted.

North East Coast Institution of Engineers and Shipbuilders

THE opening general meeting of the seventy-seventh session of the North East Coast Institution of Engineers and Shipbuilders was held on October 17, when Mr. J. B. Woodeson was installed as president. In the opening remarks of his presidential address, Mr. Woodeson called attention to the strong Continental challenge both as regards technical advances, rates of productivity and selling price, and went on to say that no doubt the years of full order books had induced a feeling of security which made it difficult to face the current harsh facts of competition.

Criticism and advice, mostly impractical, are offered by those outside the industry and who do not have the task of actually finding a solution for economic difficulties, many of which stem from taxation hampering re-equipment schemes while another factor is the lack of government credit to assist the long-term financing often essential to expand exports. Although craftsmanship, said Mr. Woodeson, was still essential, higher productivity and increasing complexity of products called for some degree of automation and mechanisation and for more detailed planning and control of the work. Success would not be achieved without co-operation at shop floor level and this required consultation and explanation so that understanding of new practices will obtain agreement to abolish the old. Another point made by the president was the question of quality in relation to selling price. Turning to steam power generation, Mr. Woodeson reviewed the progress made during the last decade particularly calling attention to the increase in boiler capacity and to thermodynamic development and to the part played by metallurgy. Units for raising steam at 3650 lb per square inch gauge and 1110 deg. Fah. are to be built while new alloys are being developed to permit of temperatures above 1250 deg. Fah. Improved efficiency of electricity generation had reduced the amount of copper and steel per megawatt while increases in fuel costs had been largely absorbed. Furthermore, continued the president, the capital cost of conventional power stations had been maintained at £50 per kilowatt installed, partly by increases in thermal efficiency and in part by the large savings effected in the building volume per kilowatt installed which has been reduced from 50 cubic feet in 1947 to 25 cubic feet in 1958.

Mention was also made of nuclear power plant developments and the problems involved in the manufacture and in the site erection of the various units, the latter of which had involved the installation of a crane with a lifting capacity of 400 tons.

Also presented at the meeting was The 1959-60 Report of the Council which records that eleven papers were presented and that the Shipbuilding Gold Medal was awarded to A. Emerson, M.Sc., for his paper " Ship Model Size and Tank Boundary Correction," while R. Atkinson, B.Sc., received the M. C. James Medal for his paper " Manufacture of Doxford Crankshafts." A three-day Symposium in Ship Trials and Service Performance Analysis was held, during which eight papers were read, the Amos Ayre Prize being awarded to Sir Victor Shepheard who contributed the introductory paper " The Prediction of Ship Performance from Model Tests : The Nature of the Problem." The report mentions that with regard to the reconstruction and housing of the " Turbinia " in the Newcastle Museum of Science and Industry, North East Coast companies have contributed guarantees totalling £10,105, while donations towards the cost of the project have amounted to £5081. The Institution Scholarship was awarded to M. F. Craig and other awards listed include the Harroway Scholarship to R. A. Young ; the Post-Graduate Grant to J. E. Turner and grants to J. L. Stewart and M. Holland ; the Swan, Hunter and Wigham Richardson Scholarship and Prize to R. H. Curry ; and the Doxford Scholarship and Prize to D. Boocock. The total number of members in the Roll is given as 2367.

Multiple-Unit Trains for Suburban Electrification

New trains built for the high-voltage a.c. London suburban electrification of the Eastern Region are equipped with liquid-cooled mercury-arc rectifiers and have a control scheme in which the use of resistances in conjunction with nine transformer tappings and a tap-change reactor provides twenty voltage steps. The trains are formed of four-car and three-car units. Two of the latter forming a six-car train are illustrated herewith.

ELECTRIFICATION on the high-voltage 50 c/s system of the British Railways, Eastern Region, suburban lines from Liverpool Street to Enfield Town, Chingford, Hertford East and Bishop's Stortford has reached the point where it is expected to have seventy-one trains operating by the end of the year. These three-car and four-car multiple-unit sets have been built by the British Railways Carriage and Wagon Works at Doncaster and York, and are fitted with electrical equipment supplied by The General Electric Company, Ltd.

The three-car units, which have been built at York, comprise a battery driving trailer, a motor coach and a driving trailer, and have second-class saloon accommodation only. Each trailer seats ninety-four passengers and the motor coach seats eighty-four, making a total train capacity of 272 seats.

The four-car units, built at Doncaster, comprise a battery driving trailer (saloon and compartment), a motor coach, a trailer coach and a driving trailer. Second-class seating amounts to 344, with an additional nineteen first-class seats in the trailer coach. Toilets are provided for the first and second class sections of the trailer coach and for the battery driving trailer saloon. The design and drawing-office work for both types of stock was carried out to British Transport Commission requirements at Doncaster, under the general direction of Mr. S. B. Warder and Mr. J. F. Harrison, Chief Electrical Engineer and Chief Mechanical Engineer, respectively, British Railways Central Staff.

The motor coaches are fitted with Stone-Faiveley pantographs and Brown-Boveri air-blast circuit breakers similar to those in other multiple-unit and locomotive equipment for the 50 c/s electrification programme. A capacitor voltage divider on the coach roof feeds the voltage-detection relays to actuate a nine-pole, oil-filled selector switch which connects the four sections of the transformer primary winding in series on 25kV and in parallel on 6·25kV. The switch, illustrated in Fig. 1, consists of contactor elements operated by insulated links from a common shaft which is rotated to one of two positions by an air engine. Although the switch is flange-mounted to the transformer, it has a separate oil supply to avoid contamination of the transformer oil. The 1000kVA transformer, (Fig. 3) is cooled by forced circulation of oil through a separate fan-cooled radiator.

The transformer secondary supplies two mercury-arc rectifier bridge circuits, each consisting of four "Com-Pak" rectifiers. Two traction motors are fed in series from each bridge, and an equalising connection between the mid-points of the motor circuits reduces the rise in voltage which develops across a motor affected by wheelspin, thus assisting recovery of adhesion. An anti-wheel-slip relay winding in this connection prevents further progression of the tap-changer if slipping develops.

A description and illustration of the camshaft tap-changer used in these equipments appeared in our October 7 issue, page 590. The control scheme provides twenty voltage steps from nine transformer taps in conjunction with series resistances and a tap-change reactor, but two of the steps have no resistance in circuit and are used for continuous running. These correspond to the series and parallel positions of the normal d.c. multiple-unit controller. A third running step is provided by tapping the motor fields after a transitional step of partial field diversion. Each field also has across it a permanent resistive shunt for smoothing, and this is reduced proportionately in value on the weak-field steps.

There is also a smoothing choke of 0·016H inductance at 230V d.c. in each motor circuit, and a centre-tapped choke for tap-change transitions. These are naturally oil-cooled air gap reactors. Motor current ripple is limited to 30 per cent at any current between half and twice the continuous rating (240A, 1475 r.p.m. at 687V on weak-field).

Fig. 2—Receptacle of thirty-six-point control line coupler. Butt contacts, replacing plug and socket connections, facilitate insertion and removal

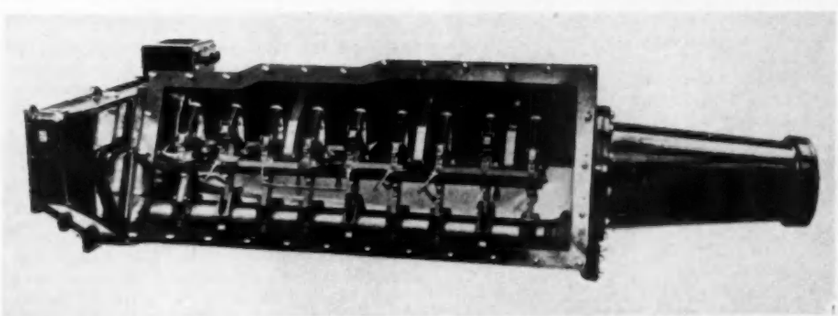


Fig. 1—Air-operated changeover switch for 25kV or 6·25kV

In general the traction motors are conventional d.c. axle-hung, nose-suspended machines, but they have been made 7 per cent larger in diameter and somewhat shorter in length than a corresponding d.c. design, in order to improve commutating conditions. This has resulted in an increase of approximately 5 per cent in weight. The permanent field divert mentioned above is 10 per cent, and reduces the flux pulsation to approximately 2 per cent. Eddy currents are reduced to a minimum by using thin pole stampings and by designing the coil springs and washers to give maximum resistance to circulating currents produced by the pulsating armature and interpole fields. Class "B" insulation is used throughout.

Fig. 4 shows the undercar rectifier case in

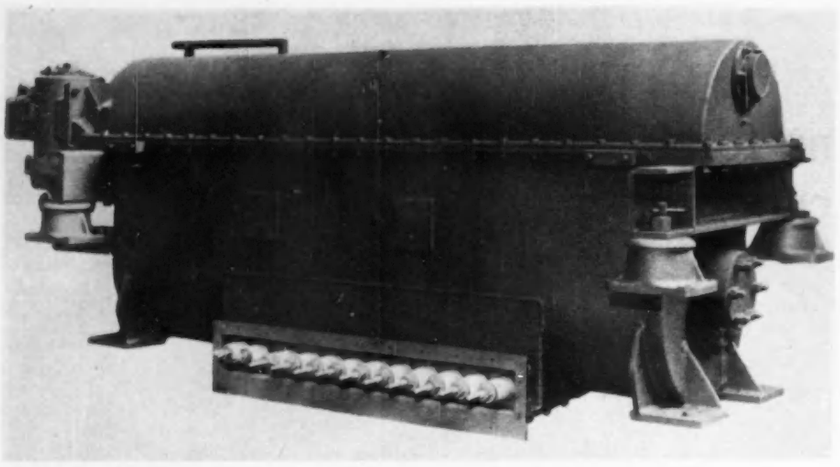


Fig. 3—Horizontal-coil motor coach transformer with oil pump for forced circulation cooling

the foreground, with the tap-changer beyond, then the control resistor case, one smoothing reactor case, and one d.c. equipment case (containing the line switches and overload relays). The rectifiers are liquid-cooled, the coolant being pumped through a single circuit from the fan-cooled radiator via the cathode, tank and anode in series.

An auxiliary supply is provided from a 240V tertiary winding on the main transformer. This supplies the single-phase capacitor-start-and-run motors driving fans and pumps, the train heating system, and a Westinghouse charger unit on the battery driving trailer, which is arranged to give a stabilised 110V d.c. supply for battery charging and coach lighting, and a 240V d.c. supply for the main air compressor. This compressor is a Westinghouse CM38 unit with integral motor, and is also carried on the battery driving trailer underframe.

Currents for the control circuits, cab and indicator lights, &c., is supplied from the battery, which also feeds an auxiliary air compressor (Reavell TBC5 with integral motor), used to provide air to raise the pantograph and close the air-blast circuit-breaker when preparing trains for service.

The master controller, of very compact dimensions, has cam-operated butt contacts, with a rocking deadman's handle and the usual reverse drum interlocking. There are four operating positions—shunting, half-power, full-power and weak field. Automatic acceleration under current limit control is provided. Rates of acceleration are 1·38 m.p.h.p.s. for a three-car, and 1·1 m.p.h.p.s. for a four-car unit.

Multiple operation of trains up to three units can be obtained. The units are also designed to operate in multiple with similar sets equipped by other contractors. Train line control circuits are carried throughout the length of the train by means of thirty-six-point silver butt contact couplers between the coaches (Fig. 2). G.E.C. couplers of this design have been adopted for all multiple-unit stock in the 50 c/s electrification programme. The application by the company of silver butt contacts to control line couplers began with the 32-point couplers for the Liverpool Street—Southend stock of 1957. These are believed to be the first examples of their use for this purpose, for which they have the advantage over plug-and-socket connectors, particularly in multi-point designs, of easy insertion and withdrawal.

Tubular electric heaters, situated under the passenger seats, are used for heating the coaches. Thermostatic control is provided for the passengers, under the overall control of the guard. The heaters, each with a maximum rating of 625W at 265V, are supplied from the main transformer tertiary winding.

Lighting is supplied at 110V d.c. from the battery charger unit. On the four-car units for the Bishop's Stortford and Hertford East lines, incandescent lamps are used throughout, but on the three-car units for the Enfield and Chingford lines the passenger lighting is by means of fluorescent tubes fed by transistor inverters, each inverter supplying four 4ft 40W tubes.

Fig. 4—Equipment cases on motor coach (rectifier case in foreground)

Excavating the Cut-off Trench for a Reservoir Embankment

A METHOD of excavating the cut-off trench of an earth dam using a cable-operated scraper bucket is being employed for the construction of the Staunton Harold reservoir near Melbourne, Derbyshire. The method is not new, but this application is claimed to be the first large-scale one in this country. The dam is being built under the direction of the chief engineer of the River Dove Water Board, and when completed it will be 1600ft long with a maximum height of 80ft, and the reservoir will have a capacity of 1400 million gallons. The main contractor is Tarmac Civil Engineering, Ltd., but excavation of the cut-off trench has been sub-contracted to the Thyssen Shaft Sinking Company, Ltd. The special scraper equipment and "slusher haulage," as it is called, was supplied by Joy-Sullivan, Ltd.

The trench is being excavated through clay and soft sandstone, utilising the following sequence of operations: after site clearance a shaft is sunk, midway along the site of the trench, to a depth some 10ft in excess of the final trench depth. The width of the shaft, i.e. that dimension which is parallel to the length of the trench, depends (*a*) upon the spacing of the cross struts, assuming that this would be kept uniform with the rest of the trench, and (*b*) whether one slusher, or two slushers working in opposite directions, are employed.

At this site, where operations began with only one slusher, a shaft with a plan of 6ft by 16ft was required, the horizontal spacing of the 12in by 12in cross struts being 7ft 6in between centres, and the vertical spacing 4ft 6in between centres. This allowed the N.221 slusher haulage to be anchored across two adjacent cross struts, leaving the other half of the shaft clear of obstruction for removal of spoil by a skip, operated from a crane at surface level. If two slushers were used with the same timbering arrangement, the shaft would measure 6ft by 23ft 6in, and the centre bay would be left clear for removal of spoil.

Using the projecting mounting frames—which hinge downward to clear the timbering when raising or lowering the slusher haulage in the shaft—the N.221 is anchored across the uppermost timbers. The haulage has two drums, each driven through epicyclic gearing from a turbine air motor developing 23 h.p. at 70 lb per square inch. A haulage wire is taken from one drum direct to the scraper bucket and the return wire from the second drum, to a return sheave, and thence back to the scraper. The bucket has a width of 4ft 6in, and has adjustable side-teeth.

Scraping operations are straightforward. The scraper bucket is hauled back to the return sheave when the power haulage is reversed and the scraper drawn towards the slusher position, cutting its own clearance. Spoil removed by the scraper falls into the shaft below the slusher and is directed by a chute into the rear half of the shaft where the skip is ready to receive it. The work must be stopped periodically (*a*) to timber the sides of the trench, and (*b*) to lower the slusher haulage to follow the level of the trench floor. In this case lowering and timbering is carried out for every 6ft excavated, and the sides of the trench are trimmed with pneumatic spades to the maximum width of 6ft prior to timbering.

The labour force consists of a team of three men operating each slusher, a crane driver on spoil removal, and four men engaged in side trimming and timbering. Output from both slushers, inclusive of halts for trimming, timbering and lowering the haulage, is approximately 190 cubic yards per twelve hour shift. The length of scrape is 95ft. On completion of each section to the final depth the slusher is brought out and the haulage mounted across the uppermost trench timbers nearest the next section, to repeat the cycle.

LETTERS AND LITERATURE

Letter to the Editor

GERMANIUM AND SILICON POWER RECTIFIERS.

Sir,—Dr. Read's article of September 30 on this subject is a timely summary, but the conclusions attach too little importance to the use of high-voltage silicon rectifier cells.

The logical, and cheapest, mounting of a semi-conductor rectifier cell is on a busbar acting as support, heat sink and electrical connection with one cell in series per rectifier arm. High-voltage cells make this simple, cheap mounting possible over a wide range of output voltages. The use of two cell types with different base polarities simplifies the construction of equipments for some connections and is often helpful, although not essential. The mounting, fusing, cooling and insulating of cells usually costs much more than the cell itself so that any reduction in number of cells reduces both cost and size of the equipment.

Industrial equipments using high-voltage cells, constructed as described with one cell per arm in series, are already so small that the rectifier cubicle is often made as a weatherproof extension of the transformer tank, or enclosure, and the whole equipment mounted out-of-doors. The permissible temperature of the silicon cell enables it to be mounted in the same enclosure as a class "B" or class "H" transformer or in the oil of a normal class "A" transformer. In some cases even the circuit breaker can be accommodated on the transformer, in a suitable enclosure, and the substation building is no longer required. This construction is applicable to the whole of the industrial voltage range. In the commonest industrial range (200V to 450V) the silicon equipment is shown by Dr. Read, Fig. 8, to be even more efficient than the germanium. Extension of these methods of construction is likely to make completely outdoor equipment the future choice for even large electrochemical and d.c. traction substations, with the virtual elimination of the large indoor "conversion station" in its present form.

For water-cooled equipment these principles lead to the simple water-cooled busbar design with clamped cells and a minimum of water connections. A germanium design with several cells in series per string logically requires one cooling chamber per cell or alternatively cooling fins and an air/water heat exchanger system ; both involving extra complications. The high-voltage silicon cell gives an equipment technically preferable in nearly every way. The small efficiency advantage of the germanium equipment for certain voltages is seldom enough to counterbalance the cost saving which results from reduction in size or elimination of the converter substation buildings.

In conclusion, germanium equipment appears to have no advantages in the industrial voltage range of 200V to 450V. For the higher voltages the slight efficiency advantage of germanium appears too small to outweigh the advantage to be gained in the future by eliminating the substation buildings or drastically reducing their size. Only below 100V d.c. for electroplating, pickling, cleaning and anodising does germanium appear to have any permanent advantage.

D. B. CORBYN,
B.Sc. (Eng.), M.I.E.E.

October 6, 1960,
Newport, Shropshire.

Book Reviews

Principles of Guided Missile Designs—Systems Preliminary Design. By J. J. JERGER. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 110s.

VAN NOSTRAND has been publishing a number of volumes in a Guided Missile series. The majority are intended to cover relatively restricted fields which will give fairly detailed specialist studies of such aspects of missiles as guidance, aerodynamics, armament and so on. However, to design a successful missile it is necessary for someone to have an adequate understanding of all these features so that they may be co-ordinated and combined in an optimum manner. This man, who was unheard of fifteen years ago, has gradually evolved with missile development into the present-day systems engineer. He is the equivalent in many respects of a project chief engineer. In both cases there are wider responsibilities than the specialist carries and greater experience is required to provide the proper background. Nevertheless, it is possible to define the problems and duties of a systems engineer more specifically than those of a chief engineer and hence a textbook devoted to the subject is possible.

The present volume aims at assessing and relating the various missile design criteria so that a broad understanding of the overall result can be obtained. In this it has been extremely successful and there is no doubt that almost all technical workers in the field and many others can find a great deal of useful information in it. It contains ten chapters, the first two being devoted to general considerations, seven to various aspects of design, and a final one on design procedure for the overall system.

Newcomers to the guided missile field will find the general considerations very useful in defining the various types of missile, guidance systems, warning systems, operational requirements and so on. These are all explained briefly and clearly and in many instances the main associated points are listed and discussed. From these the author immediately proceeds to a chapter devoted solely to reliability. At first sight this seems misplaced but, in fact, its importance in a weapon system is paramount and early emphasis is completely justified. Treatment of this subject has often been confused, in the past, by mathematical camouflage so that the average reader remains completely ignorant. This is not the case here, where the subject is illustrated with many relevant numerical examples and leads gently through probability distribution to the statistical analysis of trials.

The main approach to design considerations follows and is an interesting change from the relatively rigid treatment given in most textbooks. It emphasises the outlook which the systems engineer must cultivate so that, instead of indulging in theoretical refinements or complex analysis, he is urged to approximate and assess the limitations introduced. This is illustrated in the chapter on guidance and control which effectively covers the problems from component characteristics to servo-mechanism analysis, noise and non-linearities. The following chapters discuss the kinematics of command guidance, homing missiles, and beam riders. These each follow the same pattern, taking the reader through the principles involved, the flight paths, errors, practical features and illustrative problems. In all cases it is possible for the novice to follow the argument without difficulty and at the end to have a comprehensive understanding. This equally applies to chapters on heat transfer and structures and the final one which illustrates the various procedures discussed earlier by presenting a preliminary design of surface-to-air missile. Although the conditions laid down in this example are, of necessity, a little artificial, the care and detail bestowed upon it more than compensates and ensures that the reader has help on every feature.

Altogether this book is a worthy addition to the guided missile series. It can be read by all who are interested in the subject with the confidence that its text is never obscure and is, at all times, valuable.

Caractéristiques des Aciers. Résultats des Essais Systématiques Effectués par L'Etablissement Aeronautique de Toulouse. Publications Scientifiques et Techniques du Ministère de l'Air. No. B.S.T. 122 Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.1436.

EXTENSIVE tests have been carried out by the Toulouse Aeronautical Research Establishment regarding the behaviour of steels to the French specification "AIR 9160." These tests are reviewed in the present volume and their results are reported. The kinds of steel vary from plain carbon steel to low-alloy and high-alloy steels, and include low-alloy nickel steels.

Books Received

Engineering Mathematics. By J. Blakey and M. Hutton. Blackie and Sons, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 40s.

British and Foreign Specifications for Steel Castings. Part I. British Steel Castings Research Association. East Bank Road, Sheffield, 2. Price 40s.

Theory of A.C. Circuits. By Sylvan Fich and James L. Potter. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 35s.

Analysis of Deformation. Volume 4. *Waves and Vibrations.* By Keith Swainger. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 75s.

Foundry Engineering. By Howard F. Taylor, Merton C. Flemings and John Wulff. John Wiley and Sons, Inc., New York : Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 78s.

Joint Symposium on Instrumentation and Computation in Process Development and Plant Design. The Institution of Chemical Engineers, The Society of Instrument Technology, The British Computer Society, The Institution of Chemical Engineers 16, Belgrave Square, London, S.W.1. Price 80s.

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

Protection of Gas Plant and Equipment from Corrosion

CORROSION is now a very costly nuisance in the Gas Industry and it might remain so for a long time. The corrosion accelerating effects of thermal shock, sulphur acids and condensation of moisture always threaten to ruin the apparatus and pipelines of the gas makers, and the appliances of the many users of the gas. The subject of "The protection of gas plant and equipment from corrosion" was therefore chosen for the most recent of the valuable series of symposia which the Corrosion Group of the Society of Chemical Industry has organised since 1951. In THE ENGINEER, December 11, 1959, a report was given, on pages 784-85, of its joint symposium on "Corrosion problems of the Petroleum Industry," and before that it had held a series of eight other similar symposia, most of which were held in London.

It was joined in this latest symposium by the Birmingham and Midland Section of the Society of Chemical Industry, the Institution of Gas Engineers, and the College of Advanced Technology, Gosta Green, Birmingham, 4, where the meetings were held on September 22 and 23, 1960. The organising committee for this two day symposium balanced the programme of eight papers skilfully, and the authors all rose to the opportunities offered, presenting papers which will make the printed report of the papers and discussion of real value to gas engineers and corrosionists, when it is published by the S.C.I. in the course of a few months. This new college on which the builders are still at work made all welcome ; the hall was comfortably filled with nearly 200 participants, the amplifiers and lantern functioned properly, and the mid-session coffee and tea break lounge was convenient for informal discussions.

The first session was under the chairmanship of Mr. H. S. Cheetham, M.I.Mech.E., President of the Institution of Gas Engineers, and it commenced with an address by Dr. P. F. R. Venables, Principal of the College of Advanced Technology, Birmingham, who welcomed the participants, and stressed the importance of the subject of corrosion.

Then followed the first of the eight papers, all of which were available to those present in the form of preprints ; it was by Dr. T. P. Hoar, Lecturer in Metallurgy, University of Cambridge, on "Fundamentals of Corrosion and Prevention" and he presented it in a lively and lucid manner. He described the types of anode and cathode reactions which are commonly found in corrosion of metals in contact with watery liquids, and also discussed the combination of anode and cathode reactions in both corroding and passivating systems.

From the metal user's point of view it is the rate of the corrosion which is significant and the corrosion rate increases or decreases in Dr. Hoar's classification, thus :—

(1) Anodic attack and cathodic protection.
(2) Anodic passivation or protection and cathodic activation.
(3) Anodic inhibition and stimulation.
(4) Cathodic inhibition and stimulation.
(5) Resistance inhibition.

Many of those present clearly welcomed this brief introduction to electrochemical corrosion theory and recognised how important it is that we make more use of electrochemical and other theoretical principles in considering how corrosion occurs in practice and how it may be prevented. Dr. Hoar drove this point home by instancing a case where, through misunderstanding the functions of anodic and cathodic methods of protection, one user of stainless steel had unintentionally accelerated its destructive corrosion. The paper was planned as a stimulus to wider reading about corrosion science and therefore appropriately included a short bibliography, thirty-eight references and typical polarisation diagrams.

The second paper was by A. T. S. Rudram, of the Paint Research Station, Waldegrave Road, Teddington, Middlesex, on the "Organic Protective Coatings." The paint technologist is seldom permitted to have a single-minded approach to the maximum reduction of the risk of corrosion. Generally he must satisfy at the same time demands for decoration, identification, reduction in fire hazard, heat resistance, high reflectivity, and so on. The author envied the metal sprayers who appeared to have won the willing co-operation of engineers in properly grit-blasting the mill scale or rust coated surfaces of steel before spraying it with metal ; whereas paints were all too often wasted by applying them to inadequately prepared surfaces. He thought that the recently introduced coal tar/epoxy systems would play a major part in the protective painting of structural steelwork. On a blast-cleaned steel these systems in thick films, each application being about 5 mils, have shown themselves to possess excellent durability and good resistance to industrial atmospheres.

In the discussion Mr. N. A. Bennett referred to a bridge, under construction and not yet in use, in the design of which the engineers had permitted flat surfaces on which rain water would inevitably lodge instead of running off. Mr. E. D. Dolan, of the British Petroleum Company, Ltd., Engineering Department, had a happier contribution to make because he was able to say that through their engineers having co-operated with their corrosionists they had altered a back-to-back "U"-shaped girder to a box-shaped design. In the former it would have been impossible to prevent corrosion between the back-to-back joint in maintenance repainting operations.

For the second session the chair was taken by Mr. L. Kenworthy, F.R.I.C., F.I.M., who is the present Chairman of the Corrosion Group of the Society of Chemical Industry. Two papers were presented the first being on "The Protection of Structural Steel against Corrosion" by Dr. J. C. Hudson, now retiring from being the head of the Corrosion Section of the British Iron and Steel Research Association, 140, Battersea Park Road, London, S.W.11. This paper and the one he has prepared to be read at the Institution of Civil Engineers in January, 1961, summarise the work of many research committees and laboratory and test site investigations, undertaken since he was appointed to be "Investigator" to the Corrosion Committee, which was set up by the Iron and Steel Institute in 1928.

Recently he calculated that the cost of protective processes applied to steel in the United Kingdom during the year 1957 was roughly £200,000,000 ; half of that being on painting and a fifth on galvanising. To that great expenditure one should add the costs of many losses in production, and of other increases in costs due to corrosion.

Removing millscale by blasting or pickling was shown, by his very long-term tests on exposure racks at Sheffield, to result in as much as a five-fold increase in the life of painting schemes. Thus the average duration of protection, in years, was for weathered steel 2·3, for pickled steel 9·6, and for sandblasted steel 10·3 ; in some cases the pickled, and the sandblasted steel specimens had not failed when he concluded the tests.

The next paper was presented by Mr. H. H. Collins, of the British Cast Iron Research Association, on the subject of "Cast Iron and Corrosion in the Gas Industry." Because of its relative cheapness, castability, rigidity, and useful measure of resistance to high temperature oxidation, cast iron has been much used by the Gas Industry.

Although not intrinsically a corrosion resistant alloy it has such resistance to soil corrosion, alkalis, and many salt solutions that its history of service in the gas industry is surprisingly free from failures due to corrosion.

With aid of excellent slides he illustrated the metallography of grey and white, flake and nodular, plain and alloyed cast irons ; he also described the effects of composition and of environment on the corrosion rates, the growth of cast iron when it is used above 450 deg. Cent. and the graphitic corrosion of cast iron. Probably the greatest value of this paper will be that it draws the attention of those who are not metallurgists to the great fund of experience and unbiassed advice, now available to all engineers in the B.C.I.R.A.

the importance of the subjects under discussion was underlined by the fact that on the second day both the morning and afternoon sessions were presided over by well known chairmen of Gas Boards.

With Mr. R. S. Johnson, Chairman of the East Midlands Gas Board presiding, Mr. K. A. Spencer presented his paper on the "Principles and Applications of Cathodic Protection." He is something of a pioneer in the practical application of this method

of preventing corrosion, which has called him to travel the world over to advise on its installation.

When the Corrosion Group of the S.C.I. was formed a decade ago there were but few cathodic protection installations in the United Kingdom ; now there are some 1000-2000, from single anodes to large power impressed schemes operating on pipelines, cables, jetties, sheet piling, tank bottoms, gas holders, condensers and many other structures.

The economics of cathodic protection were sometimes striking. For example a 10in diameter welded steel pipe in a rural area might cost £10,000 per mile : say 43 per cent bare pipe at site, 44 per cent installing pipeline, 10 per cent coating the pipeline, and only 3 per cent cathodic protection installation. The annual power bill to provide the protective 1 amp. per mile, would be less than £5 per mile, which would be negligible as a maintenance or insurance charge.

There followed a paper by three authors all of whom have had practical experience of the problems encountered by the North Thames Gas Board, which spends about £1,000,000 a year replacing gas pipes. They were A. D. L. Copp, W. J. Gooderham, and E. Manners and their paper was entitled " Protection of Gas Service Pipes and Fittings." Mr. Copp thought that the old idea of allowing a margin in thickness, to give an allowance for corrosion, was now ridiculous. Doing away with screw threading was securing a very great economy and the improvement in the pipe coatings was outstanding.

By means of slides Mr. Gooderham showed the procedure, developed in conjunction with the Wellington Tube Works, by which the mild steel pipes were coated with bitumen, glass tissue and P.V.C. sheet, after first being pickled and coated with red lead on the inside. This is indeed a spectacular improvement in gas pipe coatings and the discipline of handling them.

The extensive use of electrically operated " holiday " detectors had been introduced and had proved remarkably effective. In one case reported only six holidays, i.e. gaps in the coating, had been found in 25,000ft of coated pipes, and these were due to mechanical damage and easily repairable. The old petroleum jelly bandage is still preferred by some to the P.V.C. as it is easier to smooth down. It should be borne in mind that the cost of providing a new house with gas service pipes may be £50 and since even P.V.C. is not imune to bacterial and fungal attack and sulphate-reducing bacteria may cause corrosion, there is need for a nation-wide soil survey service.

G. Le B. Diamond Esq., C.B.E., M.I.Mech.E., Chairman of the West Midlands Gas Board, presided for the final session and an excellent paper on " Corrosion and the Gas Consumer " was presented by F. C. Moody. He and his co-author C. H. Parkis, both of the Gas Council, London Research Station, Watson House, covered the wide field in a systematic manner.

First they dealt with corrosion due to sulphur oxides in gas combustion products, then with corrosion due to water, and finally with other corrosion problems. For engineers in the gas industry this well documented paper should be most valuable. In general the authors would have us conclude that corrosion problems do not seriously affect the average gas consumer. In this they may be over optimistic. The obvious solution to the sulphur corrosion problem is removal of the sulphur ; as recently discussed by the Institution of Gas Engineers. Sulphur removal is now governed by economic and practical considerations, for it is a technical possibility. Corrosion problems remain to be dealt with in instantaneous water heaters, certain types of space heaters, and some flues. It is good to see from the authors' acknowledgments that the staff at Watson House are collaborating with the corrosion section of the B.N.F.M.R.A. ; such co-operation may well accelerate the solution of some of these intractable corrosion problems, to the advantage of all concerned.

The final paper to this successful symposium was by Mr. R. E. Mansford, of Metallisation, Ltd., Dudley, on " Sprayed Metal Coatings in the Gas Industry." The principal field for metal spraying has always been the provision of metal coatings, ever since the process was introduced into Great Britain on a commercial scale in 1922. There is of course a large variety of specialised uses of metal spraying but wherever corrosion of steel was severe one may now find sprayed metal being used for protective coatings.

These are applied by one or other of three different methods, the molten-metal, powder, and the wire spraying processes, so named according to the manner in which the metal to be deposited is fed to the spraying tools.

The choice of coating for the bulk of work protected by metal spraying against corrosion at atmospheric temperatures lies between aluminium and zinc, although sprayed lead has also given good service as a coating for flue gas ducts and fans.

Mr. Mansford recalled that tests carried out by the B.I.S.R.A. corrosion staff in the rural atmosphere of Llanwrtwyd Wells, in Wales, and in the industrial atmosphere of Sheffield, had shown that a zinc coating which would have a life of thirty years in the former had only given effective protection for seven to ten years in the latter. Under the same conditions of test aluminium coatings are lasting longer in Sheffield.

The life of a coating may be extended by increasing its initial thickness or by slowing the rate of corrosion by a suitable overpainting. Work is still needed to find the best system, or combinations of paint on metal spraying, but the gritblast cleaning and metal spraying may be regarded as superior to any of the old traditional wire brushing and priming paint procedures.

In the discussion Mr. W. E. Ballard, perhaps the only man who has been actively engaged in metal spraying ever since 1922, said that metal spraying was now in the position in which electric welding found itself twenty years ago. It suffers from being too easy to use in the hands of unskilled practitioners. It needs good workmanship and adequate skilled inspection. Under those conditions engineers have faith in it as may be evidenced by the fact that 80 per cent of the giant new Forth Bridge is being metal sprayed by hand and to a large extent by mechanised metal spraying machines developed in this country.

Metallurgical Reviews

The forty-second and forty-third reviews to be published by the Institute of Metals, in its valuable series of octavo volumes, maintain the high standard set by their predecessors. No. 42 " The Theory and Practice of Vacuum Melting," by O. Winkler, of Balzers Aktiengesellschaft für Hochvacuumtechnik und dünne Schichten, Balzers, Principality of Liechtenstein, gives a well documented account of the subject listing 108 references in the text and three preliminary general literature references. It commences with a detailed discussion of the foundations of vacuum metallurgy and proceeds to the principles of vacuum techniques, the vacuum-induction-melting process, vacuum arc melting, vacuum melting in the electron-bombardment furnace and other vacuum-melting processes. This deserves recommendation as a well illustrated, scientific review of a subject which is now attracting the attention of all metallurgists.

No. 43 " Progress in Investment Casting " by Rawson L. Wood, Chairman of the Board, Arwood Corporation, New York, is relatively short, but engineers will find it informative and indeed surprising in many respects. In the U.S.A. the first shell process was commercialised more than ten years ago ; as the so-called Mercast process, in which frozen mercury is the pattern material. The investment " X " process was then developep in England and after that other shell methods have been developed under names such as Plyshell, Mono-Shell, Glascast, Alumina Shell, &c. For those desiring further details the author lists twenty-nine references.

Details are given of the Mercast, the Investment " X," and the Glascast processes ; they are compared, and their economics and probable futures discussed. Some of these processes are more suitable for small castings but using the frozen mercury pattern it has been stated that relatively large castings up to 60in long are possible.

Although the original process made use of frozen mercury as the pattern material, wax patterns are now more common. The basic advantage of shell moulds over the standard monolithic type is their resistance to thermal shock. They have some disadvantages compared to poured refractory moulds, being more fragile. At present it seems that poured refractory moulds are, from the economic point of view, to be preferred for small castings.

Obituary

LORD VERULAM

JAMES BRABAZON GRIMSTON, fifth earl of Verulam, whose death occurred on October 13, at the age of fifty, was a member of an old landed family, to whom several callings were open after leaving university. He chose to enter industry and to make his own way in this field, becoming in a short time a leading figure in non-ferrous metal manufacturing. Lord Verulam was also keenly interested in social welfare, and it is in this connection, perhaps, that he will best be remembered. For five years before the outbreak of war in 1939, he was closely associated with the work of the Subsistence Production Society of the Eastern Valleys of Monmouthshire, which, financially supported by the Government and by Lord Nuffield, made great efforts to deal with the widespread unemployment in the area. It enabled 500 of the older unemployed men of the district to produce essential goods and to own the means of production themselves. This experiment was one of the most successful of all those embarked upon at the time, and did much to alleviate the distress caused by prolonged industrial depression.

In addition to his interest in sociological matters, Lord Verulam was actively connected with management affairs, being, for some years, chairman of the British Institute of Management and the Institute of Industrial Administration. More recently, he took an interest in the plastics industry, and early in 1960 he delivered the eleventh annual lecture of the Plastics Institute.

Motor Show, 1960

No. I

The forty-fifth International Motor Exhibition was opened at Earls Court last Wednesday; it continues open daily (except Sunday) until tomorrow week. Below we commence our account of the exhibition by describing the very few new cars.

THE International Motor Exhibition held annually by the Society of Motor Manufacturers and Traders, Ltd., includes this year few new or even redesigned cars. One there is, however, from a manufacturer that has not been represented for some years, namely Lea-Francis Cars, Ltd. The new "Leaf-Lynx" is an occasional four-seater roadster, powered by a Ford "Zephyr" Mk. II engine, with three S.U. carburetters, giving 102 b.h.p. at 4500 r.p.m.; this tuning has involved the employment of tuned induction pipes, and the resulting deterioration in working speed range has necessitated not only a four-speed Moss gearbox, of mixed synchromesh and sliding gear construction, but also a Laycock–de Normanville overdrive, while the final drive has dropped to 4·1. The chassis is a ladder with two large tubes as longerons, and is underslung below the rear axle on two very long springs with reverse camber which also locate the axle. The front suspension is by double wishbones, the lower being supported by torsion bars extending back along the chassis, and the steering and suspension pivots are quite separate; lubrication is by grease gun. Short steering arms project forward within the wheels and are linked to a rack and pinion in front of the engine, driven from the steering wheel by a shaft with two universal joints. Dunlop disc brakes are used. One of the distinctive features of the car, as shown by our illustration, is a circular air intake, which is ducted to a rectangular radiator; the fan is not in the circular section but in the bonnet in front of the engine. This is one of the minority of vehicles for which performance figures are catalogued; it has a petrol utilisation of 22 m.p.g. and will exceed 100 m.p.h.

Yet another recent addition to the long cavalcade of Ford-engined specialist constructions is the Berkeley "Bandit," which incorporates the 105 E power unit. A cast iron engine is obviously not adaptable to a light front wheel drive car, and so the "Anglia" rear axle has been heavily modified to match the Berkeley swing-axle rear suspension geometry. Univeral joints requiring no lubrication are incorporated in the half shafts at the inboard ends, and the two arms of the wishbone forming the swing axle are pivoted on a line passing through the universal joint; provided no inaccuracies appear, this should result in the joints carrying nothing but torque. The front suspension is largely of "Anglia" origin but the distinctive combined drag linkage and torsion bar of the Macpherson suspension is replaced by two separate links. At the front the small Ford drum brakes are replaced by discs.

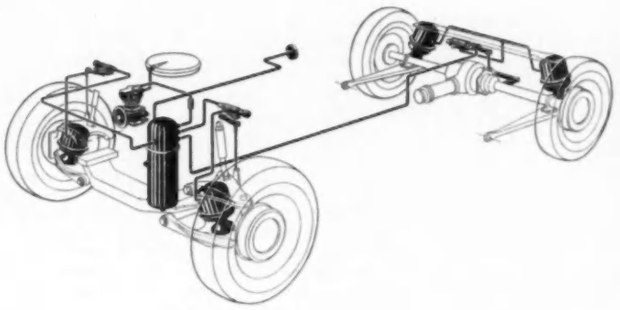
As our illustration shows, the body has the now-familiar appearance of a glass-fibre Ford special, but whereas on the front-wheel-drive cars the load-bearing structure was of plastic reinforced by light alloy, the severe stress cases set up by the heavy engine, the isolated final drive, and driving the rear wheels have necessitated a welded sheet steel structure which is stiffened by mouldings, including a propeller shaft tunnel.

Although production vehicles have not yet been tested, the manufacturers expect this open car to have a better rather than a worse performance than the standard saloon. The 105 E engine is also now specified for the Fairthorpe "Electron Minor" sports car and its saloon equivalent, the "Electrina"; these cars use "Herald" suspensions in which the universal joints and half shafts are integral constituents of the suspension. These latter cars, it will be recalled, are available in the form of kits for assembly by the operator.

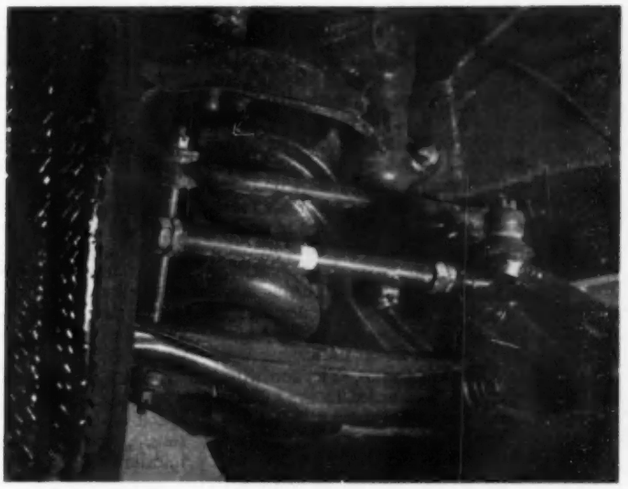
The Berkeley "Bandit" is an example of a plastic bodied sports car based on Ford working parts, but with the front brakes changed to discs

Another car to have an alternative engine offered is the Standard "Vanguard," which is now available with a six-cylinder engine of 1998 c.c. The new engine is intermediate in power between the four-cylinder "Standard" and "Triumph" engines, respectively 68 b.h.p. from 2088 c.c. and 100 b.h.p. from 1991 c.c., developing as it does 85 b.h.p. (gross) at 4500 r.p.m. The remarkable feature of it, however, is that it rejects the "Vanguard" (and "Ensign") characteristic of using wet liners. This is because it is based on the "Ten" engine—it retains the 76mm stroke, although its crankshaft is produced on different plant—and it is expected that, if modern detergent or even mixed-viscosity oils are used, the engine life will not be conspicuously inferior. The bore has increased from 63mm to 74·7mm, so that the under-square proportions of the remaining engines are perpetuated. The increased cylinder centre distance has allowed separate inlet ports throughout; the twin carburetter is an example of the new Solex semi-downdraught design, which is claimed to be the first carburetter of such inclination to have the choke and float chamber integral, although on barrel-throttle carburetters this construction has long been accepted. The six-cylinder engine fitted into the rather short car without difficulty, and the transmission is unaltered, the peak power speed having also increased (from 4200 r.p.m.).

The Lea-Francis "Lynx" 2/4 seater roadster



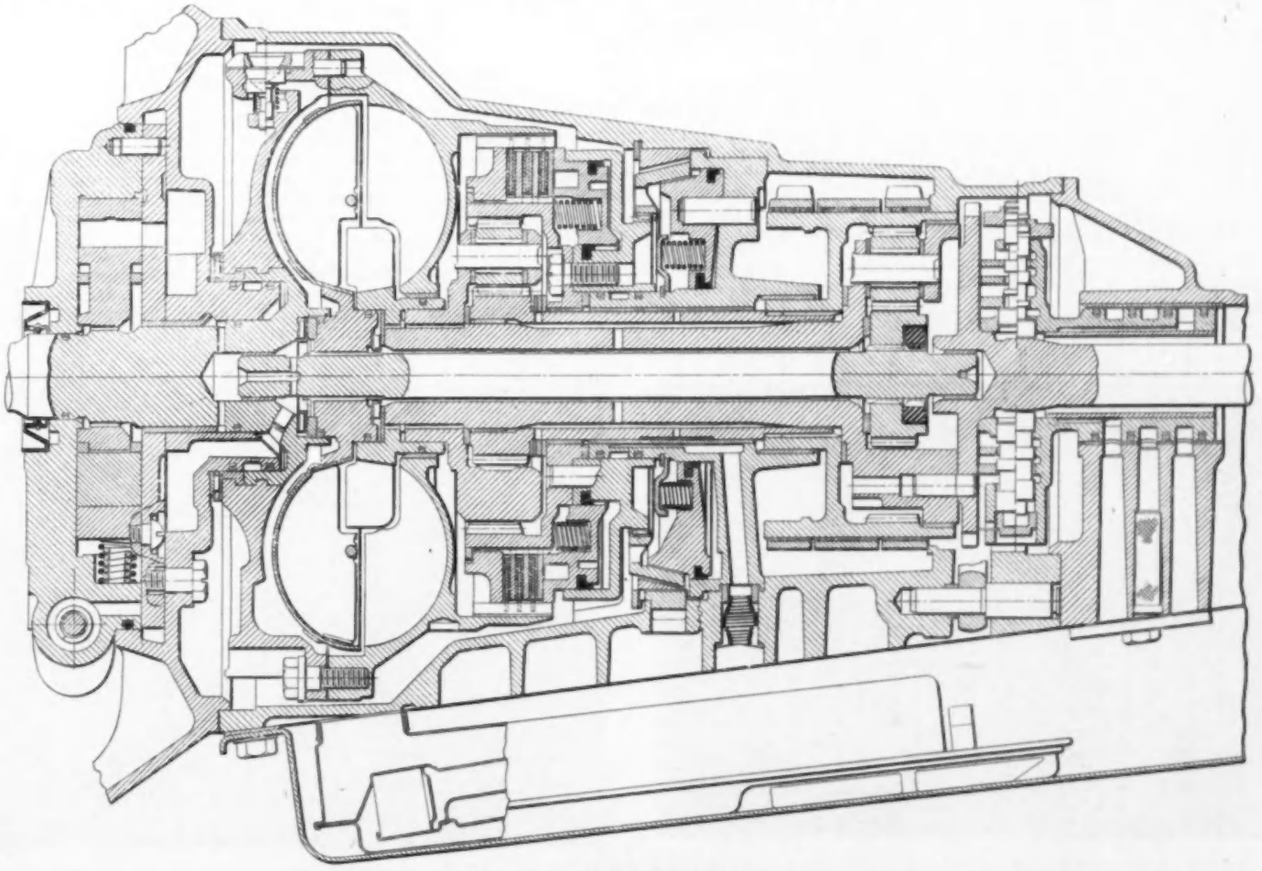
(Above) Installation of Bosch air suspension in six-cylinder Borgward



(Right) The Borgward air suspension runs at high pressures and the bellows and ballast tank are compact. Notice the telescopic damper attached to the drop arm

An exhibit of particular significance is the six-cylinder 2·3 litre Borgward with Bosch air suspension ; this is the first example of a European car with a constant rate suspension, and in fact many of the cars sold in the United States with air suspension have had steel springs with air bellows affording self-levelling. Air suspension has particular advantages for the Borgward car, which is front-engined rear-drive and therefore inherently a difficult suspension design case, particularly in the long wheelbase form in which the change in load on the rear wheels is accentuated. Continental practice proscribes the use of exposed universal joints in suspensions and hence a certain measure of swing axle geometry is accepted, and this means that the wheel attitude and hence the handling characteristics will change with load unless a powered suspension is employed. The Borgward design sets the wheels with a small positive (unstable) camber, thereby counteracting the tendency for a front-engined car to be excessively stable, and goes on to exploit further the potentialities of fluid suspension by connecting together the two rear springs so that, in the steady state, weight transfer from one wheel to the other is purely that due to the height (*c.* wheel radius) of the roll centre. Such a reduction in weight transfer is very generally sought in the front-engined car to prevent the inside wheel being deprived of adhesion by the engine torque ; it also reduces the slip angle, and adds strength to the " warning " given when the most heavily cambered (inner) wheel reaches its maximum side force. In transient changes of acceleration, in which case there will be insufficient time for transfer of air to reduce the roll stiffness, it would appear that the effect will be to improve the manoeuvrability, since the weight transfer will be increased on entering a turn and diminished, giving a higher maximum side force, on straightening out. Because of this strong damping in roll, no delay is incorporated in the response of the control valve.

A three-speed version of the " Hydra-matic " transmission, already well known in four-speed and eight-speed versions but hitherto confined to Rolls-Royce and Armstrong-Siddeley cars in this country, is now available on Vauxhall six-cylinder cars. The



Three-speed " Hydramatic " gearbox

new gearbox was developed by the Detroit Transmission Division of General Motors for cars of the class designated "compact," in which the highest performance is not sought and a three-speed transmission is adequate. Like its four-speed forebears, it retains a pair of epicyclic clusters, but both of them are connected solidly to the output and their reductions cannot be compounded in series. Our drawing shows these two clusters, of which that nearer the engine will be termed the front and that nearer the output the rear ; the two planet carriers are connected directly to each other and, through pegs, to the output. The annulus of the front cluster can be coupled to the engine by a three-plate clutch or to the casing by a cone clutch or, rather, brake. The sun wheel of the front cluster is coupled to the annulus of the rear, and the assembly can be stopped by a band brake. In place of the coupling of the familiar "Hydramatic" there is a converter with a stall torque ratio of 1·3, known as an "Accel-A-Rotor;" the turbine drives the sun wheel of the rear cluster and the "stator" is mounted on the planet carrier, i.e. the output. For starting from rest, the band brake is engaged and the "stator" and turbine are therefore geared together ; the additional torque sustained by the turbine is, of course, supplied by the output (planet carrier) but, since the turbine runs faster than the "stator" with a ratio 3·03, a nett torque increase of 1·2 is observed ; this is a very significant improvement in efficiency compared to a pure coupling at high slips. When the vehicle speed rises and the converter passes the speed at which the torque on the "stator" is zero, the power input to the stator will become positive, but of course three times as much power will be subtracted from the turbine ; since the torque ratio of the converter is so low, these losses are unimportant.

In the condition discussed above, low gear, the annulus of the front cluster is rotating forwards at a speed 1·58 that of the planet carrier, i.e. half that of the engine at low loads. To engage middle gear the multi-plate clutch is closed, bringing the annulus up to engine speed, the "stator", up to $\frac{1}{1\cdot58}=0\cdot633$ engine speed, and the turbine up to $\frac{1}{1\cdot58}\times3\cdot03=1\cdot92$ engine speed ; the converter is therefore emptied, by the valve seen at the top of the pump, in middle gear.

When, therefore, the band brake is released, the rear annulus will accelerate forwards and the speed of the sun wheel and the turbine will fall. The forward motion of the rear annulus, which is the front sun, will increase the speed of the first planet carrier, and this is the top gear condition. It can be visualised that, under no load, both clusters will rotate at very close to engine speed, and the converter will run in the same way as a converter-coupling beyond the coupling point ; one-third of the torque will be transmitted by the converter. As the load is increased, however, the speed of the first sun/second annulus will be forced down and the turbine will gain, not lose, speed, so that in fact in top gear the converter is acting as a hydro-kinetic retarder and "slip" is negative. Clearly, this tendency for the sun-annulus member to lose speed under load means that, given a torque-sensing control, on-load changes between middle and top ratios could be perfect.

The unusual arrangement of the converter in this transmission is shown to advantage when reverse gear is considered ; both turbine and "stator" are then doing positive work. The condition for the "stator" to run slowly in the opposite direction to the turbine is for the second annulus to run fast in the reverse direction, and is created by closing the cone clutch and stopping the first annulus.

As well as the usual *P*, *N*, *D*, *L*, *R* selections, *S* is provided to hold in middle (second) gear ; neither *L* nor *S* becomes effective unless the speed is low enough for them to engage safely. The operation of the box is, of course, hydraulic ; our drawing shows the main oil pump in front of the converter. At the opposite end can be distinguished the toothed wheel which is locked for *P* and driven from the planet carrier by pegs. This wheel cannot be disconnected from the planet carrier, and if the car is to be towed more than 50 miles the propeller shaft must be removed.

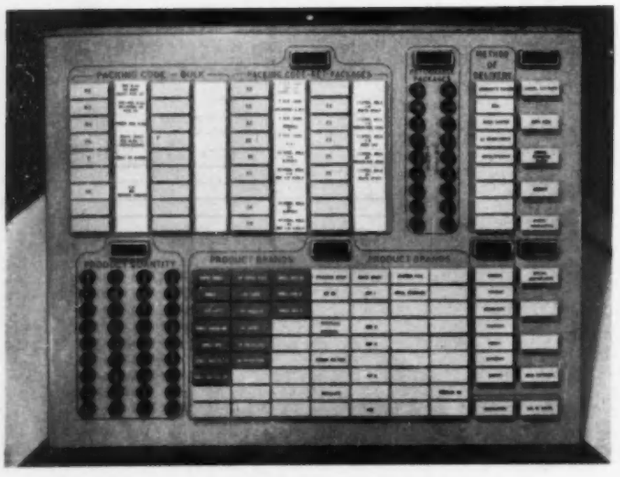
(*To be continued*)

Recording and Invoice System

DEVELOPMENTS in methods to maintain internal efficiency at a level to assimilate expanding business have been undergoing tests at the Royston storage and distribution installation of Shell-Mex and B.P., Ltd., which was described in our issue of April 29, 1960, One development is concerned with operations, and consists of a master panel, located in the office of the installation manager, designed to give the closest control of the quality and movement of products from the offloading from railcars into storage to the loading of road vehicles at the gantries. The panel which is arranged in the form of a flow diagram shows the temperature and the levels of products in the tanks and embodies push buttons to open or close inlet and outlet master valves controlling flow.

A second experiment tried out at Royston is called "Doris" and consists of a number of machines working in partnership in a direct-order-recording-and-invoicing-system. This has been devised to mechanise the clerical work at the depots, which was mainly manual and repetitive, and to provide error-free data in a form suitable for later machine processes to supply statistical information. It was decided that electro-mechanical rather than electronic means should be adopted and the system was designed on this basis. The heart of the equipment is a seven-sided input console which has 3000 buttons carrying the names of customers arranged in alphabetical order. On receipt of an order by telephone the operator presses that customer's particular button to set the system in motion. Facing the operator is a central panel, illustrated below, by means of which, by pressing the appropriate buttons, the basic information regarding a particular order is recorded as received over the telephone. The quantity required is ordered by pressing the numeral buttons grouped in the section product quantity and the appropriate button in the product brands section is depressed as is that referring to the day of delivery. Other buttons are concerned with packing codes, and there is a button for special instructions, while a buzzer and an appropriate red light call attention to the failure to record a particular item of information. When all particulars of the order have been recorded the transaction and end-of-order buttons are depressed. The former enables an order for several products to be recorded while the latter clears the console for the next order.

The information is perforated on paper tape which is read automatically, and the production of the issue document begins. The particulars of the current order as recorded on the input console have to be augmented by full information concerning the customer and the products and this is stored on reels of seven-channel strengthened paper tape. When the input reader mechanism identifies the customer number the reels are rotated. Meanwhile the seventh channel holes are scanned by a photo-electric cell until the customer information is reached and then the reels are stopped and the printing of the sales ticket commences. Similarly the product details are selected from the product store reel when the input reader mechanism identifies the product required. Some of the static customer information and terms of trade reels are shown in our illustration. Also printed on the sales ticket are product description and price and the value of the order calculated. The equipment makes a permanent record of orders for accountancy purposes and for statistical processes a summary is punched on tape.



Central panel of input console

Static information reels

"Nuclear Clean" Workshop at Erith

To provide "nuclear clean" conditions for the manufacture of all plant for the gas coolant circuit of a nuclear reactor, a special workshop has been established at the Erith Engineering Works of The General Electric Company, Ltd. of England. The object of this "nuclear clean" workshop is to prevent equipment destined for the gas circuit from being exposed, during manufacture, to "contamination" by materials which would have an adverse effect on the operation of the reactor. Below we describe the workshop and its functions.

STRICT manufacturing control is needed to exclude from the gas circuit of a graphite-moderated gas-cooled reactor, any materials that might adversely affect the performance of the reactor and might even prevent criticality from being reached. This requirement means that any equipment destined for use in the gas circuit must be subject to special handling conditions during all stages of manufacture as well as during installation on site. For the first part, covering manufacturing operations, special provisions have been built into a "nuclear clean" workshop at the Erith Engineering Works of The General Electric Company, Ltd., of England.

Special control is exercised from the time the parent metal enters the works and is maintained on each component of the gas circuit throughout its manufacture, culminating in a final operation of cleaning, preserving and packing in the "nuclear clean" workshop, as described below.

The unwanted materials can be grouped, roughly, under three headings : (1) neutron absorbers, (2) dusts capable of easily becoming highly radioactive, and (3) materials which have an adverse effect of a metallurgical or chemical nature.

The presence in the reactor core of a greater quantity of neutron-absorbing material than the designed amount would impair the reactor efficiency, and in an extreme case could prevent its operation. The danger lies not only in materials trapped in the core components themselves, but in dust which may be carried into the core by the coolant gas. In general, boron, cadmium and cobalt must not be allowed to enter the gas circuit at all (unless included by the designer) since they have high neutron-absorption characteristics. This is also true, but to a lesser degree, of chromium, manganese, platinum, rhodium, tungsten and vanadium, although manganese in carbon steel is acceptable, since the quantity is usually insignificant.

Generally most kinds of dust are capable of becoming radioactive and then settling in parts of the plant subject to normal maintenance procedure, such as the steam-raising units. Another danger is that radioactive dust can affect the operation of the burst cartridge detection equipment, by settling on or near the detectors and causing false operation of the system.

For these and other reasons aluminium, copper, molybdenum nickel and selenium dusts, in addition to the dusts of the metals mentioned earlier, must be excluded from the gas circuit. The obvious course is to remove all dust, scale, swarf, &c., from all items scheduled for this part of the plant, and to avoid accidental contamination by dusts during all stages of manufacture before installation. This removal is one function of the "nuclear clean" workshop and the associated Process and Preservation Shop.

Certain metals react chemically with the fuel-element cans, in some cases forming undesirable alloys with the metal of the can. The four most important to be excluded from a reactor core are mercury, tin, bismuth and lead. Alloys and compounds of these and other metals must also be treated with suspicion, and prevented from coming into contact with "nuclear clean" plant.

In general, equipment needing to be "nuclear clean" can be classified, roughly, into two categories. Broadly speaking, those items of plant which are close to the fuel elements form category 1, and those further away from the core and which therefore come in contact only with the coolant gas, form category 2. There is, of course, overlapping between the two categories, but they provide the basis for a manufacturing procedure to be laid down for each item of plant requiring to be "nuclear clean."

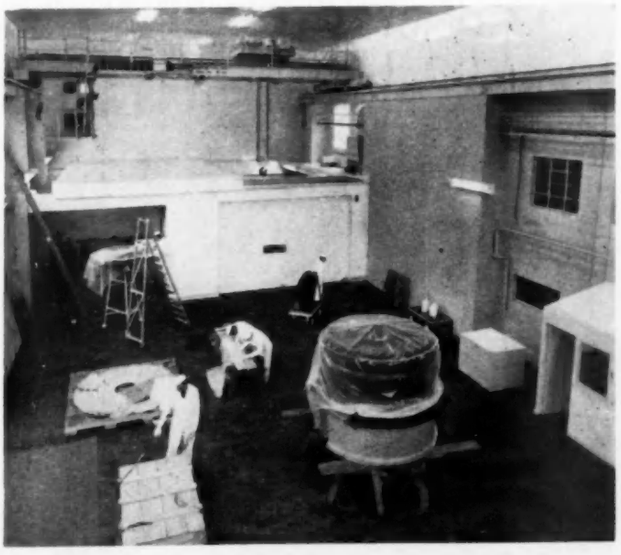
Plant in category 1 has to be treated carefully from the start of manufacture until it is finally installed on site. This requirement involves the correct choice of tools when machining and preserving the component during its passage round the factory.

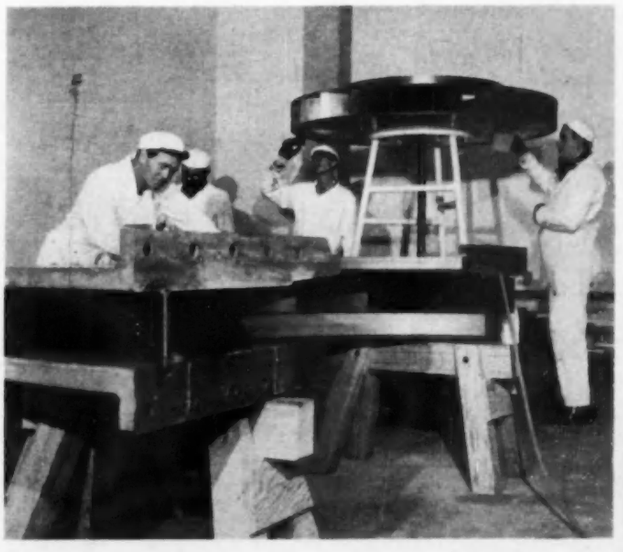
Treatment of plant in category 2 is not necessarily so critical in the early stages of manufacture : the "nuclear clean" process may start with the entry of the component into the Process and Preservation Shop.

Typical items in category 1 are : fixed channel tubes ; stainless steel tubes in the control-rod standpipes ; garter restraints ; control rods, their mechanisms and motors ; channel-cooling circuits ; thermocouples and fixing clips ; television cameras ; and the charge machine. Other components can generally be considered to be in category 2 but each component calls for individual assessment.

"Nuclear Clean" Workshop

The "nuclear clean" workshop is part of the existing Process and Preservation Shop, extensive modifications having been carried out to meet the new requirements. The major modifications included the partitioning of the building into two, thus separating the "nuclear clean" workshop from the Process and Preservation Shop; the fitting of a false ceiling; the building of a reception bay with a sliding roof; and the provision of a room to serve as a personnel entrance from the outside to the clean-conditions area. Furthermore, the assembly area, reception bay and room for personnel entrance had to be pressurised to prevent foreign matter from entering while any door is open. In addition the ceiling, dividing partition, reception bay and part of the walls had to be lined with suitable material; the granolithic floor had to be sealed; and the exposed areas of the walls coated with metal-free paint. The di-





(Left) "Nuclear clean" workshop, showing reception bay roof open and the crane in position to lift a component into the assembly area—(Right) Impeller and half a diffuser of a gas circulator for Hunterston nuclear power station (South of Scotland Electricity Board) in the paint bay of the "nuclear clean" workshop

mensions of the " nuclear clean " workshop are 85ft 6in by 42ft 6in by 30ft high including the reception bay which is 25ft square by 11ft 3in high.

To enclose the roof space, prefabricated " Girdalinc " timber beams, at 4ft centres, were used to bridge the 20ft span between trusses. Timber connectors between adjacent beams formed a grid-like framework to which " Laconite " (melamine-surfaced hardboard) was fixed to form the false ceiling. Similar construction was used for a framework upon which to fasten the " Laconite " boarding for the dividing partition, and the reception bay. The vertical asbestos cladding which formed the upper part of the original building was similarly faced.

The floor of the original building had been heavily coated with a lead-based paint. It was necessary to remove this completely by means of pneumatic fettling tools, and then to seal the floor with " Sealocrete " Special Sealer TP73C.

The specification for the special paint used on the exposed steelwork and brickwork was rigorous, as indicated in the accompanying table.

Paint Specification

Application	Aggregate of group 1 metals per cent	Aggregate of group 2 metals per cent	Aggregate of group 3 metals per cent
Primer	Nil*	1·0	3·0
Undercoat and finishing ...	Nil*	0·1	1·0

Group 1 metals : Mercury, boron.
Group 2 metals : Borium, bismuth, cadmium, gallium, indium, lead, lithium, thallium, tin, zinc.
Group 3 metals : Aluminium, antimony, calcium, cerium copper, nickel, praseodymium, silver, strontium.
* Nil in the case of boron means not more than fifty parts per million.

The reception bay, although part of the " nuclear clean " workshop, is capable of being isolated from the assembly area to enable final cleaning and inspection to be carried out before items or materials pass into the assembly area. Entry to the reception bay from the outside is by means of a Potter Rax door 16ft wide by 10ft 6in high. A second door is provided in the dividing partition which separates the reception bay from the Process and Preservation Shop. Thus items treated in this shop can pass directly into the reception bay. Interlocks are fitted between the three doors and the sliding roof to prevent more than one being open at a time. The purpose of the sliding roof on the reception bay is to enable large pieces of plant be lifted into and out of the bay as required by the 10-ton overhead travelling crane (illustrated). A simple winch arrangement moves the roof, which is mounted on rollers, to give an opening 23ft by 16ft.

In addition to the pressurising, which is achieved with dust-free temperature-controlled air, other special features in the " nuclear clean " workshop include cleaning and filtered compressed air services located at strategic points; facilities for preservative spraying; and the adoption of suitable surfaces on the interior of the building for easy cleaning. The plant necessary to provide these services has been located outside the workshop in a new annexe to the existing building. A small colossus-type crane to assist with assembly work, and fitters' benches of new clean wood are also provided in the workshop.

Ventilation and Pressurising Plant.—This plant consists of an air filter system capable of handling 35,000 cubic feet per minute (including 5,000 cubic feet per minure for preservative spray extraction), and an air heater capable of raising the same quantity of air from 30 deg. Fah. to 70 deg. Fah. when supplied with hot water at a mean temperature of 170 deg. Fah. A three-way modulator valve to the air heater is controlled by a thermostat situated inside the duct in close proximity to the fan, and a room thermostat placed at a convenient point in the workshop. The air heater is fed by a calorifier with an output of 2·5 million B.Th.U. per hour under normal operating conditions. The distribution of the air inside the assembly area is by four " Deflecto " grilles, each 60in by 36in, mounted in the gable end opposite the dividing partition. Two 24in by 10in in the personnel entry room provide the pressurised filtered air for this area, and two 15in diameter " Airmaster " diffusers fitted above the Potter Rax door meet the needs of the reception bay.

Vacuum Cleaning Plant.—The capacity of the vacuum cleaning plant is such that four operators can work simultaneously on the various cleaning duties at any of the seven points provided. Five of these points are located in the assembly area and two in the reception bay. The plant incorporates a horizontal, multi-stage turbo-exhauster driven by a 20 h.p. screen-protected three-phase squirrel-cage motor ; a dust separator ; a textile filter having an external, hand-operated shaking mechanism ; and a removable dustbin.

Compressed Air System.—Compressed air at 100 lb per square inch, is supplied to eight outlets from an existing source, the only modification required being the fitting of a ceramic filter in the incoming line. Four of these outlets are located in one corner of the assembly area, which is set apart for the spraying of components.

Cleaning and Preserving Processes

The cleaning and preserving consists of removing scale, rust, dust and grease, coating with " Trilac " and encasing the component in a polythene container. A bagged dessicant comprising activated alumina in pellet form, is placed inside the container before it is heat-sealed, the quantity being dependent on the estimated time of storage, since the polythene container is slightly permeable.

Except for the final vacuum cleaning and preservative spraying, all other cleaning processes are done in the Process and Preservation Shop adjoining the " nuclear clean " workshop. Two different procedures are generally followed, depending on whether the item is a machine part or not. If it is not then, depending on its size, it is either shot-blasted or pickled in an inhibited 10 per cent solution of hydrochloric acid and then is immersed in phosphoric acid. Next the component is delivered to the " nuclear clean " workshop for any assembly work necessary and for spraying with " Trilac."

For a machined or bright part, a trichlorethylene vapour bath is followed by a wash in a similar fluid, and a one-to-two minute dip in phosphoric acid. The component is then ready for final cleaning assembly, preservation and packing.

After being cleaned in the Process and Preservation Shop the component is brought into the reception bay of the " nuclear clean " workshop, through the door between the two shops. It is then cleaned by any convenient means including vacuum cleaning, inspected and passed from the reception bay into the assembly area through either the door or the roof. If required it is then sprayed with " Trilac " in the small area adjacent to the reception bay set aside for this operation, as illustrated. The preserved parts are then assembled if necessary, checked and packed in sealed polythene bags as explained earlier. When the plant is finally sealed in its bag it is taken out of the building through the reception bay and stored under cover until needed on site.

The main contractors who participated in the building and equipping of the workshop are as follows : Building, F. Ling and Co., Ltd., Kent ; ventilation plant, J. Jeffreys and Co., Ltd., London ; vacuum cleaning plant, Sturtevant Engineering Company, Ltd., London ; paints, Atlas Preservative Company, Ltd., Kent ; floor sealer, Sealocrete Products, Ltd., Kent ; timber beams, Newsum Sons and Co., Ltd., Lincoln ; melamine-faced hardboard, Laconite, Ltd., Surrey.

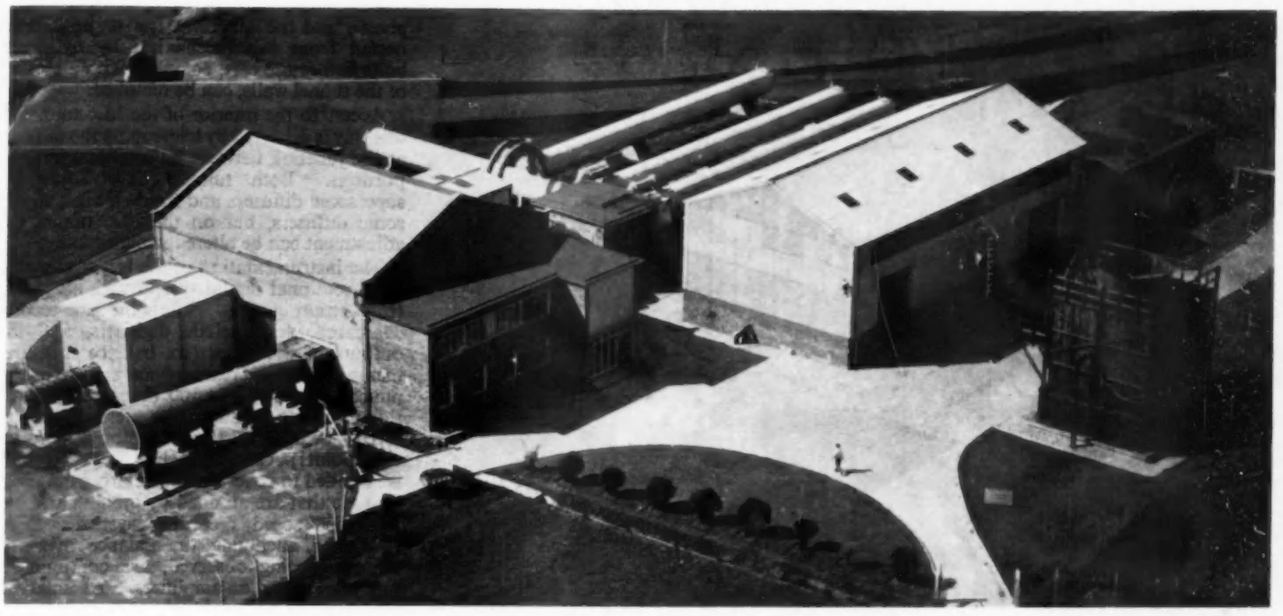
High Speed Wind Tunnels

Two large blow-down wind tunnels were opened last Wednesday by the Minister of Aviation at the Warton aerodrome of English Electric Aviation, Ltd. One, of 4ft square section, is limited by liquefaction to M.4 but will run down to M.0·4, while the other, of 1ft 6in section, has an air heater and will, when completed, have a range of M.1·5 to M.6·0.

TWO new wind tunnels have been added to the four (one low speed, two transonic, and one water) in existence at the Warton, Lancashire, airfield of English Electric Aviation, Ltd., a member company of British Aircraft Corporation. One is intended mainly for aircraft development ; it has a speed range from M.0·4 to 4·0 and a working section 4ft square. The other is described as a guided weapons tunnel ; it will have a speed range of M.1·5 to 6·0, and a working section 18in square.

The larger tunnel can exceed a Reynolds number of 5×10^6 on an 8in chord throughout the speed range, with running times ranging from twelve seconds at low Mach numbers to a maximum at Mach 3·4 of over forty seconds. The smaller tunnel is intended to simulate the full scale Reynolds number at 80,000ft or above on a 17in model of a 50ft vehicle ; at Mach 2·8 an R_e of 60×10^6 should be attainable on such a model. The running time will range from four minutes up to nine minutes at M.4·7 and 6½ minutes at M.6.

The two tunnels share a common air supply. Two three-stage reciprocating compressors deliver a total of 6 lb per second of air at 600 lb per square inch ; the air is not only intercooled but also aftercooled to 70 deg. Fah., the power of the two 820 h.p. motors being dissipated from the cooling tower seen at the right in our illustration. A small alumina drier reduces the humidity to 3×10^{-4} by mass, or 6×10^{-6} if one compressor only is used. The reservoir consists of four Whessoe pressure vessels of 6ft i.d. and 90·5ft overall length, each containing an 8-ton stack of galvanised 18g. steel sheets, alternately flat and corrugated, that form a heat source (as opposed to a sink) to maintain the delivery temperature of the air, which would otherwise drop to —125 deg. Cent. during delivery ; as a



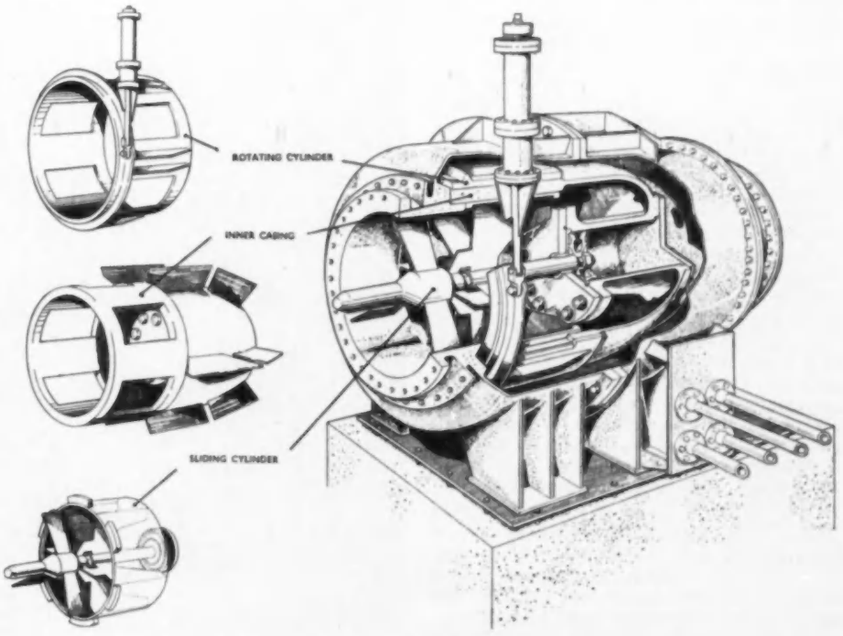
The supersonic tunnel site ; anti-clockwise, the cooling tower, the compressor and drier house, the storage vessels, the control and observation building, and the subsonic diffusers. The light-coloured building around the exhaust of the smaller tunnel houses the telescoping section

result the drop in temperature during a run is only 25 deg. Cent. The remainder of the plant is separate for each of the tunnels, but as the tunnels are basically similar—and conventional—our description will deal with both control valves together, both nozzles, and so on, the differences between the two being specified where necessary.

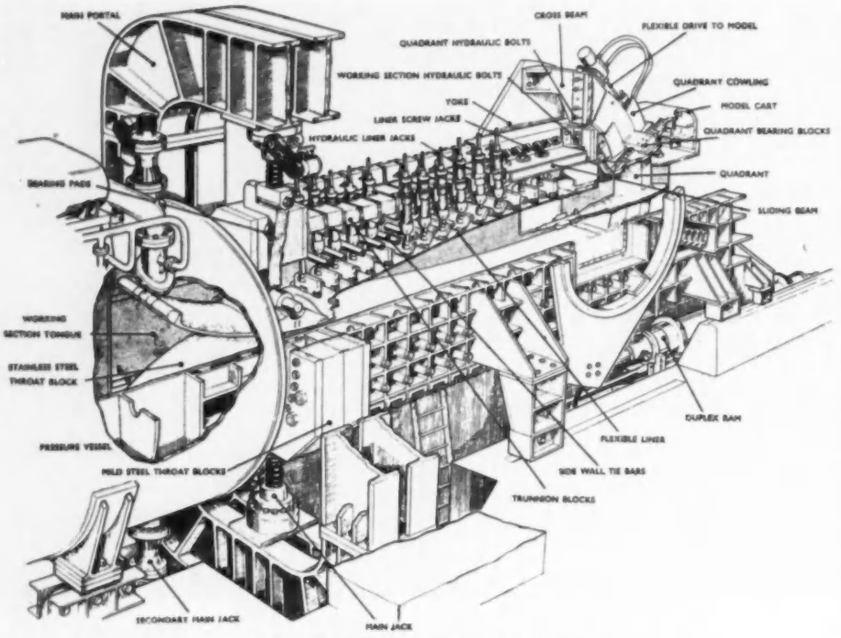
Because of the very wide working speed range, the control of flow in the 4ft tunnel was expected to prove exacting, and English Electric undertook the design of the control system itself. The characteristics of the control valve were the finishing rather than the starting point in the design of the system, and called for a two-stage device in which the first stage opened to an extent inversely proportional to the upstream pressure—the constant of proportionality being varied with the desired density—and the second stage responded to errors in the selected pressure drop along the tunnel. A feature to which particular attention is called is the ability to alter the stagnation pressure during a run for buffet or flutter tests or the measurement of dynamic derivatives—at this stage it appears that it will not be necessary to do this simply to protect the model, because the combination of a rapid start with a long nozzle has resulted in zero incidence lift coefficients at starting not exceeding unity. The valve to exploit this control system had to handle a mass flow of 3350 lb per second and dissipate about 60,000 h.p., while responding to commands at up to 10 c/s ; in addition it closes the 600 lb per square inch reservoir when shut. It was made by Johannes Erhard H. Waldenmaier, of Heidenheim, and is a sleeve valve of 3ft 6in bore weighing 12½ tons. Our illustration shows clearly its construction ; the first stage consists of a piston directly coupled to a hydraulic ram and varying the length of the ports in the sleeve, while the second consists of a ported cuff which rotates to vary the width of the ports. The piston was originally austenitic, but this gave rise to galling (a piston in a cylinder is unstable when gas is flowing through the radial clearance, the pressure being highest where the clearance is highest—hence despite the piston-rod being guided, normal forces of the order of 100 tons were experienced). The piston has now been clad with bronze, and an oil mist is dispersed into the air in the reservoir—this mist, which remains in suspension until it contacts a solid body, has not been found to influence the results of the tunnel tests. This valve closes automatically when any dangerous pressure condition in the tunnel is detected, while in between runs the ram of the sliding member is held shut by reservoir pressure as a precaution against the loss of pressure from the normal hydraulic control system, which is energised by gas cylinders.

The smaller tunnel has separate shut-off and control valves ; the system is that of the Compudyne Corporation and has been installed in several wind tunnels in the United States of America. The shut-off valve is an 18in butterfly valve in which the butterfly is an interference fit in the sealing ring, the latter being heated by embedded electric elements to unseal it and the butterfly moved by a hydraulic ram. The regulating valve is a 10in Morgan Smith valve with a conical rotating plug which can be seated axially to afford a seal ; a hydraulic actuator controlled by a Moog valve will maintain the pressure drop through the tunnel within ±0·0025 of the desired valve.

In the smaller tunnel alone there is a heater downstream of the control valve ; it consists of five stacks, each of over 3 tons of steel plates, with a 500kW electric element in each. The heater units are mounted on wheels to reduce the time needed to remove them for maintenance. This heat source will keep the stagnation temperature within ±2 per cent of the mean temperature ; its design maximum temperature of 225 deg. Cent. is needed at M.6, while total temperatures of 112 deg. Cent. at M.5 and 35 deg. Cent.



Two-stage control valve for M.0·4—4·0 tunnel



Nozzle and working section of M.6 tunnel

at M.4 are necessary to avoid liquefaction.

Both tunnels have flexible-walled nozzles and working sections of the well-known Hall Engineering construction. Since there is ample time to adjust the nozzle between runs, the settings are made by screw jacks which are moved one at a time ; the principal jacks, those setting the throat size, have electric motors installed, while the secondary screws defining the contour of the divergence are set manually with the assistance, in the case of the larger tunnel, of a power nut-runner. Since the settings are not made at all points in unison, it is not possible, or at least safe, for the flexible wall to be anchored to the screw jacks, and, in fact, the walls normally stretch straight from the throat to the working section and are brought into contact with the screw by sets of hydraulic rams when the tunnel is to be used. On the larger tunnel the screw jacks and hydraulic rams are separate, but in the smaller special Electro-Hydraulic rams with adjustable trave stops are used. In both cases the accuracy of profile is 0·002in. Curvature sensing devices protect the flexible walls against human errors in setting the co-ordinates. The flexible walls are sealed against the plane walls by inflating tubes recessed in their edges. For the larger tunnel, the range of movement at the throat is from 2·5in to the full 48in depth of the tunnel.

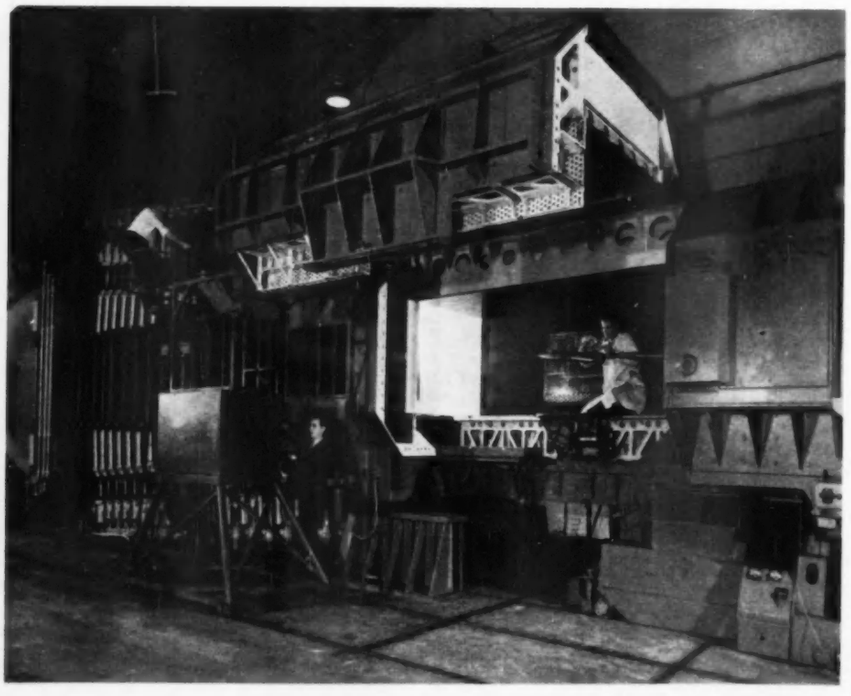
The larger tunnel includes, downstream of the normal working section, a transonic working section with perforated walls of 19 per cent porosity. Outside this section is an octagonal plenum chamber, and one side of it hinges upward for access to the working section. The perforations in the side walls are arranged to coincide to afford observation of model and flow, while for improved visibility " Perspex " panels may be fitted.

The models are mounted on stings carried by moving quadrants ; as our illustration shows, the larger tunnel can have a cranked sting to allow up to 5 deg. yaw to be applied without rolling the model. The sting joints in the larger tunnel are interchangeable with those of the Aircraft Research Association transonic tunnel (see page 479, May 11, 1956) and the R.A.E. 8ft by 8ft tunnel (see page 21, July 5, 1957). The smaller tunnel has a sting adaptor to R.A.E. (Farnborough) No. 19 tunnel design. This sting can have the slip ring unit for the strain gauge balance removed and a General Design Corporation " Scanivalve " substituted, so that only one pressure lead need be lead off the cart. The larger cart can, as our illustration shows, be wheeled either up- or downstream after insertion to place the model in either the supersonic or transonic section. The smaller cart is considerably more complex ; as our drawing shows, the incidence mechanism embraces the tunnel, the schlieren windows being within the quadrant pivots, and the quadrant has to be disconnected from this mechanism by hydraulic bolts before the cart, complete with a section of the tunnel walls, can be removed.

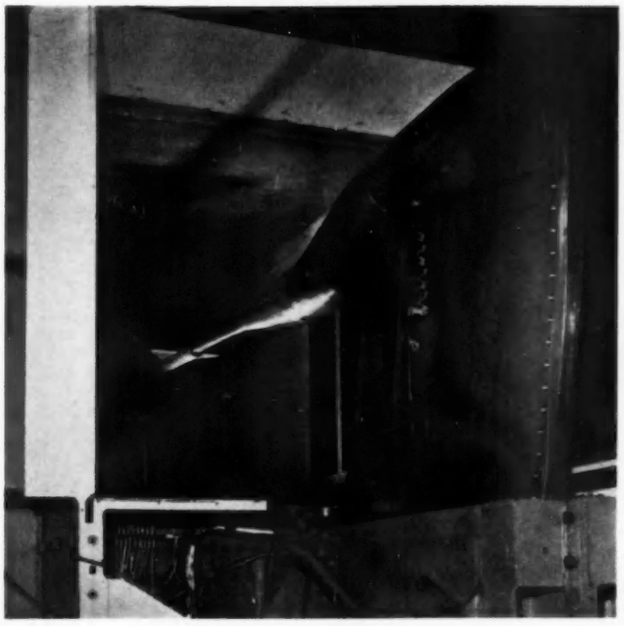
Access to the interior of the M.6 tunnel in this way is achieved by telescoping the diffuser at the junction between adjustable and fixed portions. Both tunnels have adjustable supersonic diffusers and fixed circular supersonic diffusers, but on the M.6 tunnel the adjustment can be altered while running.

The instrumentation of the larger tunnel is a conventional digital system with all inputs from strain guages. The nine one-second chart recorders include digitisers, and the outputs of the latter (six balance measurements and three pressures) are transferred to punched cards up to 100 times per minute. For sampling of numerous pressures, up to three " Scanivalves " are employed at forty-eight points per second each. The M.6 tunnel is intended to cover the much larger ranges of attitude that are attained by missiles and has a higher speed recording system. Eight quantities, including the balance measurements if being observed, are continuously presented by d.c. amplifiers. At intervals separated by one-eightieth second, sampling amplifiers store these eight values and present them in sequence to a Packard Bell " Multiverter " which converts them from analogue to digital form and transfers them in binary code to a high-speed store (the output is, clearly, 640 numbers per second) of magnetic tape. Subsequently the tape record is transferred to punched cards, which, with those from the other tunnel, are processed by a " Deuce " computer. To give the staff immediate indication of what is happening, there is also a pure analogue system recording twelve channels on sensitised paper. Both tunnels have schlieren systems ; that for the M.6 tunnel has three positions along the axis of the section, and will move from one to the next under automatic control in five seconds.

The supersonic tunnel facility has cost £750,000 ; the large tunnel has run and has



The transonic working section ; notice the " Perspex " panel in the farther perforated wall. The cart has been drawn downstream to bring the model " Lightning " into the transonic section. The hydraulic jacks that load the nozzle wall are conspicuous ; at the top of the divergence an operator is adjusting the screwjack settings



A calibration model on a cranked sting in the supersonic section of the M.4 tunnel

demonstrated satisfactory control at the very low pressures used at the minimum running speeds. The tunnels will be used in the development of such projects as the TSR-2 and the " Blue Water " tactual bombardment missile ; a photograph of a model of the latter showed a slender vehicle with a long ogive nose, a distinct boat-tail, four large chamfered fins at the tail in the traditional manner, but two only " wings " amidships with the shape and presumably the function of those of a " Bloodhound". These " wings " are very small, but presumably a roll-stabilised and near-ballistic trajectory is followed ; the inference is clear that the vehicle has been designed to avoid the problems of vectoring the thrust of a solid motor.

Pantograph Current Collection Studies

ATTAINMENT of uniform traction current collection from a static overhead wire traversed by a pantograph mounted on a moving train is a problem of direct interest to the British Insulated Callender's Cables Group. Contact pressure between the two components is continually changing, and this fundamental effect becomes more important as higher supply voltages and, hence, lighter overhead wires are used, and as running speeds increase.

For information on the performance of his equipment, the designer has hitherto had to rely almost entirely on observations made on the actual railway track, but such observations are difficult, lengthy and of limited accuracy. The B.I.C.C. Group has, therefore, augmented its research facilities by setting up a new laboratory designed specifically for research of this nature by means of a scale model capable of reproducing faithfully all the dynamic mechanical characteristics of the full-scale equipment at simulated speeds up to at least 100 m.p.h. This model has been operational for some months in the laboratory at Tolworth.

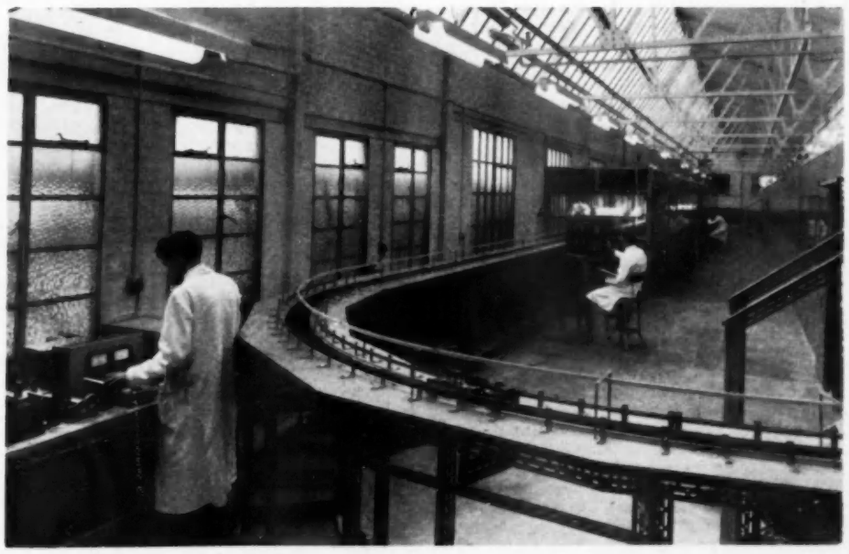


Fig. 1—Laboratory and test track, showing enclosed, temperature-controlled test sections

The laboratory housing the model measures about 200ft by 20ft, and as seen in Fig. 1 combines a track in the form of a closed loop with two straight sides, 144ft in length, and closing curves 14ft in diameter. At the middle parts of the straight sides are the actual test sections 80ft in length, enclosed and temperature-controlled. A trolley (Fig. 2) about 12in long, driven by a 50V d.c. motor supplied with current from the rails, is used as a vehicle for the pantograph and the necessary instrumentation. The motor is underslung to lower the centre of gravity and avoid the risk of derailment at the curves. The scale of velocity is such that an actual train speed of 100 m.p.h. is represented by a model running speed of nearly 18 m.p.h.

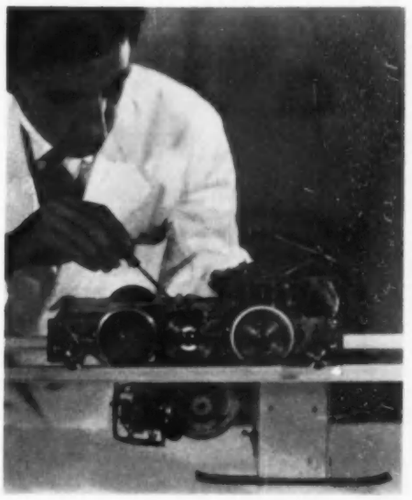


Fig. 2—Trolley carrying model pantograph and equipped for transmitting data

The three arrangements of overhead equipment—simple catenary, compound and stitched catenary—which have been designed and are being installed by B.I.C.C. for the British Railways 25kV a.c. system are being reproduced. The solid contact wire and the stranded catenaries are represented by fine wire on which closely-spaced cylindrical beads are fixed to give the correctly scaled mass and elasticity. In all, more than 300 beads are used in each 1ft length of model contact wire.

The first form of support to be studied is the hinged cantilever, consisting of a diagonal strut tube supported from porcelain insulators by a stranded tie-wire and hinged at the vertical mast. The upper end of the strut tube holds the main catenary, but the auxiliary catenary and contact wire are attached to hinged registration and steady arms.

Position, velocity and acceleration of the pantograph trolley are data which must be known at all times. These are gathered from devices which feed back high frequency signals to a receiver from a transmitter carried underneath the trolley. The transmitter aerial consists of two underslung flat plates spanning a receiver aerial wire carried by the supporting structure. Movements and displacements of the wires in the model are measured in several ways, either optical or electrical, which may be used separately or in combination. The optical methods are high-speed cinematography, and a method which registers the position of a wire by casting a shadow of it on to a photo-sensitive device. The favoured electrical method employs a capacitive coupling to a high-frequency signal carried by the model wires. The results of the last two methods, together with signals from the trolley instrumentation, are simultaneously displayed on a multi-trace oscilloscope with recording camera, or on a multi-channel chart recorder.

SHORTER REPORTS

Successful Graduates Section Venture

LAST week-end the Graduates Section of the North-Western Branch of the Institution of Mechanical Engineers held an "Autumn Conference" in Buxton. It is, we think, the first time any Branch Graduate Section of that Institution has held such a function and we are very glad to add that it turned out a success. The theme of the conference was that of "Widening the Engineer's Horizon" and it was realised by getting a number of well-known people to speak on certain very broad topics. Miss J. Woodward, Lecturer in Industrial Sociology at Imperial College, London, led off on Friday evening, October 14, with a talk on "Shop Floor Relationships—Co-operation or Conflict". On the following morning there was a talk on "The Presentation of Information" by Mr. B. W. Pendred, Editor-in-Chief of this journal. The same afternoon Mr. Litherland, Head of the Art Department, Royal Technical College, Salford, spoke on "Aesthetics in Engineering"; and in the evening Mr. A. J. J. Moulam, Extrusion Specialist, Imperial Chemical Industries, Ltd., presented a lecture on "Plastics in Engineering". On the Sunday morning the subject of "What an Engineer should Know" was taken by Mr. W. K. Martin, Chief Engineer, John Player and Sons, Ltd., of Nottingham. Each of those contributions to the conference led to a lively discussion.

The conference came to a conclusion at a luncheon on the Sunday at which those present were addressed by Mr. G. McOnie, Chairman of the North-Western Branch of the Institution of Mechanical Engineers.

The Launch of H.M.S. "Dreadnought"

BY OUR NAVAL CORRESPONDENT

IT is nearly six years since the submarine "Nautilus"—the first nuclear powered ship in the world—went to sea. She steamed, for the most part submerged, 62,000 miles before it was necessary to refuel her—to change her reactor core. By then she had proved conclusively that the nuclear power plant had eliminated the two main drawbacks of the underwater vessel—the need frequently to surface and her poor mobility submerged. The success of the "Nautilus" induced the American naval authorities to "marry" a nuclear power plant to a more efficient type of underwater hull—known as "tear-drop"—which, in an experimental diesel-electric drive submarine, gave a remarkably high submerged speed for as long as her battery lasted. The result was the U.S.S. "Skipjack" which commissioned last year and provided the prototype for H.M.S. "Dreadnought"—to be launched by H.M. The Queen to-day at Vickers-Armstrongs' yard, Barrow. As originally planned, the "Dreadnought" was to have been fitted with a British designed and built nuclear reactor, but in 1958 an agreement was concluded with the United States Government for the purchase of a complete set of propulsion machinery of the type fitted in the "Skipjack". This agreement has enabled the submarine to be launched far earlier than would have otherwise been possible. The supply of this machinery is being made under a contract between the Westinghouse Electric Corporation and Rolls-Royce Ltd. The latter are also being supplied with design and manufacturing details of the reactor and with safety information, and have now set up a factory in this country with a view to manufacturing similar cores. The reactor is a pressurised water type, which will drive a single shaft through steam turbines. Almost every electrical and mechanical part of the propulsion machinery is installed in duplicate so as to minimise the inconvenience of breakdowns. In addition, every control feature of the power plant and of the ship has been duplicated. These innovations will ensure an extremely high standard of reliability which, combined with the need to refuel at only very long intervals, will give her the ability like other nuclear submarines to undertake patrols of particularly long endurance at continuous high underwater speeds.

With a length of 266ft, a beam of 32ft and a surface displacement of about 3,500 tons, the "Dreadnought" will have a hull of British design both as regards structural strength and hydrodynamic features, although the latter are based on the pioneering work of the U.S. Navy. From about amidships aft, the hull lines will closely resemble the "Skipjack" so as to accommodate the propulsion machinery. The forward end of the ship is wholly British in concept. In the Control Room and the Attack Centre the instuments are fitted into consoles. She will be fitted with an inertial navigation system and with means of measuring her depth below ice. The inertial navigation system is a method of accurate navigation under water, completely automatic, invulnerable to detection or jamming and independent of ground-based aids. It consists essentially of an assembly of very accurate gyroscopes and accelerometers with associated servo-amplifiers, arranged and inter-connected to form an accurate gyro-compass with a stabilised horizontal platform. Her primary role is as a submarine hunter killer for which purpose she will be equipped with the latest developments in underwater weapons and detection. It is not Admiralty practice to give speeds and performance of new submarines, but as the "Dreadnought" has only a 14ft greater length than the "Skipjack" and has the same hydro-dynamic features it may be assumed that the two vessels are handled and controlled on much the same lines. The "Skipjack" is unofficially credited with a submerged speed of over 40 knots. This means that she literally "flies" through the water and that new devices have had to be developed to control her when submerged. The forward hydroplanes have been removed from the bows to the conning tower (which the Americans now call the "sail") and are operated, no longer by a wheel, but by an aeroplane type of "joy" stick, with the operator strapped to his chair by a safety belt. Speed and depth indicators have also been provided to show the position and speed of the submarine a few minutes in *advance*, provided that in the interval she maintains her prevailing acceleration. These indicators improve reaction time by the control personnel. Key personnel from the crew of the "Dreadnought" have been trained by the U.S. Navy. This type of training will later be carried out in the United Kingdom when the reactor and machinery installed ashore at Dounreay are in operation. Anyone who has been lucky enough to visit the "Skipjack" will not be surprised at the excellent accommodation and facilities the Admiralty is providing for the "Dreadnought's" complement of eleven officers and seventy-seven ratings—a standard which it has been impossible to attain in any previous submarine. The improved water distilling plant will for the first time provide unlimited freshwater for shower baths and for the washing machines in the fully equipped laundry. Separate mess spaces will be provided for senior and junior ratings, arranged on either side of a large galley, which is equipped for serving meals on the cafeteria system. Particular attention has been paid to the decoration and furnishings of the living quarters and to the recreational facilities which will include cinema equipment, an extensive library and tape recordings, all of which will help to offset the monotony associated with prolonged underwater voyages. The "Dreadnought" is expected to commission late in 1962.

Overseas Students in Britain

THERE are now about 47,500 students from other countries in Great Britain—a four-fold increase in ten years. To provide up-to-date information on the question of who the students are, where they come from, who sponsors them, what arrangements are made for their reception, welfare and training, the Standing Committee of the London Conference on Overseas Students, c/o The British Council, 3, Hanover Street, London, W.1., has issued a new and expanded handbook entitled "Overseas Students in Britain".

The booklet shows that the students have come from more than 130 countries—Commonwealth and foreign—and that more than half of them are living and studying in the London area. Both in London and in the rest of the country, they are widely distributed among universities, technical colleges, teacher training colleges, nursing institutions and private colleges. Universities and technical colleges, as would be expected, have the greatest individual numbers of students. The range of subjects being studied is very large, but there is a bias in favour of technical studies. From the statistical tables provided in the handbook it is clear that in the universities, students of arts subjects are the biggest single group (4403 out of a total of 11,001), but if pure science (1472) and technology (2545) are taken together, the total engaged in technical studies (4017) is the second largest group. In the technical colleges the largest single group (3200) out of the total of 11,944 is engaged on G.C.E. studies, closely followed by the engineering group, which is 3030 strong. If engineering, mining, science and building are taken together, the total of 4489 shows how marked is the interest in technical subjects. Besides those undergoing training in teaching institutions, there is a smaller but significant group of students receiving practical instruction, usually in the works of manufacturing concerns.

The Sampling of Traffic

(CONTRIBUTED)

"THE Sampling of Traffic" was the subject of the paper discussed by the Traffic Engineering Study Group of the Institution of Civil Engineers at the opening meeting of its second winter session on October 13. The paper was presented by F. Garwood, M.A., Ph.D., F.S.S., Head of the Statistics and Planning Section of the Road Research Laboratory. The chairman was Mr. H. J. B. Harding.

Introducing the paper with numerous slides of graphs showing the periodic variation in traffic flow at typical points on the British highway system, the author revealed the basis of the considerable progress that has been made towards the sufficiently accurate estimation of hourly, daily, and even annual, flows from a relatively brief sampling. The paper, which was largely devoted to the mathematics of the subject, made the point that a high degree of accuracy becomes necessary only when the flow exceeds, or threatens to exceed, the economic capacity of the road. This economic capacity, at which the flow renders road widening a paying proposition in terms of traffic costs saved in relation to the capital outlay, is found to be somewhat greater than the standard capacities for rural roads laid down in Ministry of Transport Circular No. 727. However, it was made clear, early in the discussion, that those standards are being raised : in passenger car units per hour, from 4500 to 6000 for two-lane carriageways, and from 9000 to 11,000 for three-lane carriageways, though the figure for dual two-lane carriageways remains 25,000.

Another, related point was cleared up after speakers had queried the fixed rating, at three passenger car units, of a vehicle such as a bus, the congestion effect of which could range from fifty-five in a city to one on a motorway ; the

answer came that the passenger car unit was devised solely for rural roads. Previously a traffic engineer from abroad had remarked that a satisfactory unit of mixed traffic remained elusive ; he had been much struck by the high proportion of commercial traffic on M1, which he estimated at 35 per cent ; he predicted that M1 would become one of the busiest commercial routes in the world.

As an instance of the guidance on sampling already available there can be quoted from the paper, " the prediction of the annual flow from an hour's count is most efficiently made from a Monday, anytime between 9 a.m. and 7 p.m., in April or September." While welcoming the economy of being able to rely on sampling as a basis for such predictions, the contributors to the discussion mostly concentrated on those numerous occasions and circumstances where there could be no satisfactory substitute for a full-scale count or survey ; " sampling is always sampling," said one. And there was a lower note of confidence in urban sampling than rural.

There was unanimity, however, over the value of the concept of " economic capacity." Compared with practical capacity it provides a more logical approach, was one view expressed ; and, although the formulæ in the paper related it only to road width, Dr. Garwood explained that it could also be applied to the treatment of intersections. It therefore seems, from the interest shown on this occasion, that the term economic capacity is likely to gain increasing circulation among traffic engineers in this country. Meanwhile it can be noted that the factors implicit in economic capacity are fully dealt with (though the term itself is not employed) in Road Research Technical Paper No. 48, " The Assessment of Priority for Road Improvement," by D. J. Reynolds, B.Sc., June 1960, H.M. Stationery Office, 2s. 6d.

First Effluent and Water Treatment Exhibition and Convention

THIS week the first effluent and water treatment exhibition has been in progress at Seymour Hall, London, W.1 ; it closes to-day. Forty exhibitors, who include well-known manufacturers serving this field, are showing products for treating sewage and trade effluents, for purifying water for domestic use or for boiler feed, or for process usage, and also instrumentation to measure the efficacy of these various processes. The organisers believe that this is the first exhibition of its kind that has been held anywhere in the world.

The exhibition is accompanied by a convention which includes the presentation of fourteen technical papers, the discussion of which has been in progress at morning and afternoon sessions for the duration of the exhibition. In general the papers take the form of reviews of current practice in the particular subject selected ; for instance " Pumping", " A New Outlook on Marine Water Treatment", and " Problems of Dosing in Effluent Treatment Plant", to name three titles.

The treatment of boiler feed water figures quite prominently at the exhibition. Automatic treatment and recording is emphasised over the whole field, and there is to be seen plant for use with especially corrosive solutions. In this last category are a range of remotely controlled valves exhibited by the Saunders Valve Company, Ltd., whose new developments include a rubber-lined non-return valve and a solid p.t.f.e. valve. This firm's exhibits contains a selection of the wide range of lined valves available, which includes rubbers such as neoprene and ebonite, metals such as lead or titanium, and plastics such as nylon and polythene. The range of diaphragms is so comprehensive that it is claimed that virtually all fluids may be controlled by Saunders valves.

Evershed and Vignoles, Ltd., is demonstrating two ranges of instruments for analysing and determining impurities in solution, namely the " Dionic " conductivity measuring instruments and Tinsley Polarographs. Where an effluent has to be controlled and a large number of related analyses have to be performed frequently, the polarographic method enables the analyst to delegate the task to semi-skilled assistants once the method is established. Measurements of overall pollution may be linked to the available oxygen. In this method, the firm states, polarography represents " an elegant and sensitive method which has already been adopted to form part of a continuous flow circuit". It is also possible, for example, to distinguish Cu, Cr, Cd, Zn and Ni in a single sample, and to determine quantitatively Cd, Zn, Ni and Cu together, assuming no chromium to be present. Organic materials used in the manufacture of plastics may also be measured in waste.

For measuring conductivity, the pipe-type " Dionic " conductivity cell makes it unnecessary to withdraw a sample of the solution to be tested. The cell embodies automatic temperature compensation in the range of 60 deg. Fah. and 200 deg. Fah., and is suitable for operation at pressures up to 200 lb per square inch. In view of the " continuous " mode of operation of the cell, it has been provided with a bronze gate valve so arranged that the electrode unit may be withdrawn for cleaning or inspection without the need for a " shut down " of the plant.

Mobile Radio Committee Report

IN its fourth report, published on September 30 (H.M. Stationery Office, price 9d.), the Mobile Radio Committee submits proposals for reducing channel spacing from 50 kc/s to 25 kc/s in the v.h.f. high band (165–173·05 Mc/s). Similar narrow channelling in the low band (71·5–58 Mc/s) came into force on June 1 last year. The report has been approved by the Postmaster General.

The position in the high band is somewhat complex, the report states, since the changeover from 100 kc/s to 50 kc/s channelling recommended in the committee's second report is still in progress. About 3500 of the old 100 kc/s sets are still in service, and users may continue to operate them until January, 1962. Other users are operating their services with a mixture of 100 kc/s and 50 kc/s equipment, together with equipment that is expected to be suitable for 25 kc/s channelling. Meanwhile figures show that the number of stations in the land-mobile bands as a whole has doubled itself every three years, and the committee thinks that no time should be lost in introducing 25 kc/s channelling for users in the high band. It recommends, therefore, that after January, 1961, all new land-mobile systems in the high band should use equipment meeting the 25 kc/s specification. With few exceptions, the 25 kc/s equipment standard will also apply to additions or replacements for existing services. When replacement of obsolete 100 kc/s equipment referred to above is completed by January, 1962, the main group of new channels will be ready for use. By interleaving 25 kc/s channels between existing 50 kc/s channels sixty-four additional two-frequency channels will be provided, and, for the first time in the high band, there will be some channels for the general purpose, public transport, and municipal and public service categories. No change is recommended in the existing allocation of single-frequency channels.

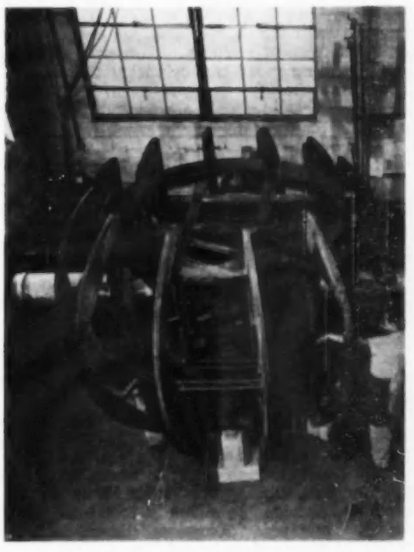
Although f.m. equipment was not included in the field trials of 25 kc/s channelling, it is understood that the Post Office has since gained some experience of 25 kc/s f.m. equipment under test conditions in the public mobile service in South Lancashire, which operates on frequencies close to the high band. It is therefore recommended that users who particularly wish to install such equipment on 25 kc/s channels in the high band should be allowed to do so, pending the issue of a final specification.

The report also mentions that the move of mobile services from television Band III to the high band has yet to be completed. This was a very live issue in 1954 when the committee was appointed but, in the event, it has not been necessary to press the mobile users to change the frequencies of their equipment solely to avoid interference with television, apart from a few services that were involved when television Channel 8 was brought into use. In consequence, there are still 110 mobile systems, with a total of about 1200 base and mobile stations, working on frequencies within television channels 6 and 7. However, unless those channels are needed for television services within the next eighteen months (which is understood to be somewhat unlikely) the problem will clear itself up. All the equipment in question is the old 100 kc/s pattern, which is due to be replaced by January, 1962, in any case, and the users will be allotted the appropriate high band channels for their new equipment.

Wood Laminate Supports in a V.L.F. Radio Transmitter

WE have received some interesting information about the contribution that is being made by a British firm, Permali, Ltd., Bristol Road, Gloucester, towards the construction of a very-low-frequency radio transmitter for the U.S. Navy.

This transmitter, which is designed for communicating with submarines submerged to depths of 100ft, is being built by the Continental Electronics Manufacturing Company, of Dallas, Texas. Radio signals from the transmitter, using a frequency band of 14 to 30 kc/s, will be



Rotor structure fabricated in densified wood laminates for the variometer used with the new U.S. Navy very-low-frequency radio transmitter

capable of being picked up by surface ships and shore stations, and by submarines without risking detection by sending an antenna-bearing periscope above the surface.

The role of Permali, Ltd., in this £20,000,000 project is to part-design and engineer (as a sub-contractor to the Continental Electronics Manufacturing Company) the complete fabrication of strong light-weight dielectric supports for two variometers and two helical coils. The material used for these support structures consists of Permali densified wood laminates, built up of selected grades to give maximum strength in the required direction. The same non-magnetic material is used for all the nuts, bolts and dowels in the assembled structure.

Each variometer consists of a rotor and a stator to provide variable inductance for circuit tuning and measures overall 21½ft high, 13ft long and 12ft wide. The rotor, supported by a specially designed tube of approximately 12in diameter, and enclosed by the stator structure, carries approximately 4000 lb of 3·4in cable, and is so designed that the angular distortion during operation will not exceed ten minutes of angle. The stator, likewise, is wound with 3·4in cable, weighing about 5000 lb.

Each helix coil support measures 34ft high and 22ft diameter, carries 25,000 lb of cable and provides a fixed inductance in the transmitter circuit. The support consists of twelve box-design columns erected in a circular pattern and jointed at several points with tie-braces to give rigidity to the load-bearing members.

All the structures were manufactured by Permali Inc., Mount Pleasant, Pa., U.S.A., in close technical co-operation with the parent company, Permali, Ltd., Gloucester.

[Reply Card No. E6813]

SHORTER REPORTS *(Continued)*

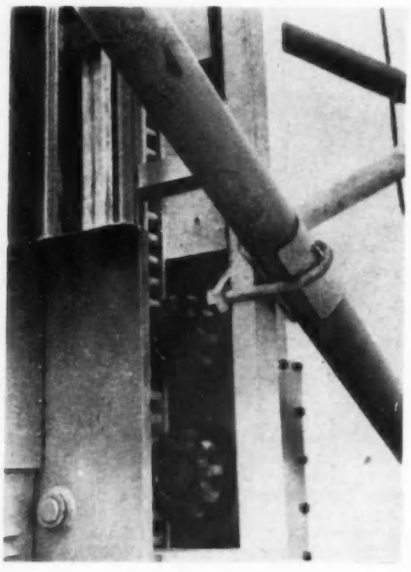
Self-Climbing Lift

THE Alimak mast lift, which is now available in this country, is completely self-contained. It is powered by a petrol engine, with a drive pinion meshing with a rack integral with the single rail on which the travelling carriage runs. The lift is made by Alimak Verken A.B., Sweden, and marketed in Great Britain by A.C.E. Machinery, Ltd., Harlequin Avenue, Brentford, Middlesex. In the form in which it is illustrated here, the lift is designed for installation in a television aerial mast, where it is used for inspection and maintenance purposes. The basic feature of the lift, however, the rack rail with its travelling carriage and pinion drive, is adaptable in various ways. It can be used, for example, with the rack inclined, as well as with it in the vertical position. The size, capacity and operating speed can be varied over a wide range, and the lift can be fitted with any kind of passenger and goods accommodation, from a simple platform to an enclosed, heated and lighted cabin.

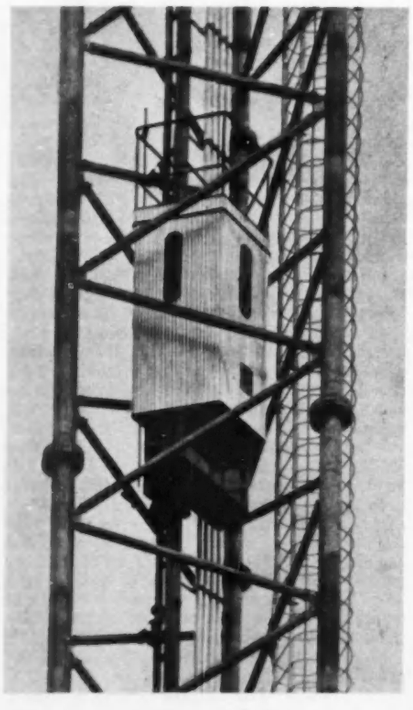
The rail on which the lift runs is of fabricated steel, and has the rack of open or " pin " form ; this simple construction ensures that if ice should form on the rack, it is crushed and pushed out by the pinions as the carriage moves. Ice-breaking blades, fitted to the carriage, clear the track for the running wheels. The rail is in standard lengths of 2½m (8ft), each length weighing about 140 lb. A piece of rail can therefore be carried on the top of the lift, which erects its own track up the mast. A crew of three men can be carried, the maximum payload being 1100 kg (2400 lb).

A wheeled carriage running on the rail is used to support a steel framework, and part of this frame is sheeted in with corrugated aluminium to form the man-riding cabin. On the top of the cabin, tubular steel handrails and a toe-plate are provided to enable it to be used as a working platform. Access to the cabin is by means of a trap door in this working platform. The petrol engine used for propulsion is mounted below the cabin and removable doors are fitted to the engine compartment to give access for maintenance. In addition, a trap door in the floor of the cabin allows simple engine adjustments to be made.

The drive from the engine is taken through three worm gear sets housed in a single box, and so to three pinions meshing with the rack. Smooth running is ensured by setting the pinions out of phase with each other. As the worm gears are self-sustaining, the lift can be held at any point in its travel simply by switching the engine off. Reversal of direction is effected by direct reversal of the two-stroke petrol engine, and the lift is driven upwards and downwards at the same maximum speed, 1ft per second. A hand throttle in the cabin enables the engine speed to be varied. To prevent overrun, a control rod extending right through the cabin makes contact with fixed stops at the upper and lower limits of travel and cuts off the engine ignition. Spring bumpers at the top and bottom of the guide rail provide an extra safeguard.



Close-up of climbing rack and two of the pinions



Alimak lift installed in a television mast

To control the movement of the lift it is only necessary to switch the engine on and start it in the appropriate direction. A directional switch and indicator lights are provided in the cabin for this purpose. When the carriage is brought to rest by the overrun stops, the engine rotation is automatically reversed, and it will only start in the direction required to move the carriage away from the stop. A choke of the normal type is fitted for starting the engine from cold, and a pedal-operated clutch enables the drive to be disengaged for engine starting. There is no neutral gear ; to stop the carriage it is only necessary to switch off the engine. Controls are also provided in the cabin for the heating system, for internal lighting and for an emergency signal hooter. A plug point for an inspection light is also fitted, and there is a built-in recorder to show the number of operating hours. All the electrical equipment is run from a 12V battery housed in the engine compartment and charged by the engine in the normal manner.

A fourth pinion engaging with the rack is used to drive a centrifugal governor-controlled safety-brake, and this comes into operation if the speed in either direction should reach 2ft per second, that is double the normal speed. This emergency brake can also be operated directly by manual control from a knob in the cabin. A carbon dioxide fire extinguisher is mounted on the cabin with its outlet directed at the engine, and it can also be removed and used by hand if necessary. The 2·65-gallon petrol tank has a three-way tap operated from inside the cabin and giving " on, " " off " and " reserve " control—in the latter position nearly a gallon of the total tank capacity becomes available. In case of complete failure of the engine, it can be disengaged from the drive and the lift can then be wound down manually by means of a handle kept in the cabin.

[Reply Card No. E6821]

Rectifier Transformers for Cross-Channel D.C. Power Link

Two rectifier transformers for the d.c. power link between Great Britain and France are being built at the Walthamstow works of Fuller Electric, Ltd., a member of the Hawker Siddeley Group of companies. The individual transformer output is 95/95/65MVA., three-phase, 50 c/s. Each transformer has three windings giving a no-load voltage ratio of 284/86·3/33kV, with a tapping range of ±15 per cent, controlled by a Fuller high-speed, resistor-transition, on-load tap changer which is arranged for automatic control.

One winding, rated at 95MVA, is connected to the 275kV Supergrid ; it is star-connected and has tappings at the neutral end. The second winding, also rated at 95MVA, supplies the anodes of the converter/inverter valves at 83·6kV ; a six-phase anode supply is produced by having the anode winding star-connected on one transformer and delta-connected on the other. The third winding on each transformer is delta-connected to supply at 33kV, a capacitor bank which provides reactive power for the commutation of the converter valve groups. The same winding also provides the main auxiliary supply for the station.

The core, which is built up of cold-reduced grain-oriented sheet steel, is of three limb construction and the active material weighs 89 tons. The arrangement of the windings on the core is unusual in that the 275kV winding is the inner winding, as mentioned above. This layout, which was governed by the impedance requirements of the converter plant, involved a considerable increase in overall dimensions to provide the necessary clearances. Next to the core is a multi-start coil containing the voltage regulating tappings associated with the 275kV winding, the tappings being arranged in such a way that magnetic balance is maintained whichever tap number may be in use. Next outwards from the core is the main 275kV winding. Surrounding the 275kV winding is the 33kV delta-connected winding for supplying the capacitor bank. The outermost coil is the anode supply winding which has the number of turns corresponding to a voltage of 83·6kV but is insulated for 132kV ; it has an outside diameter of 7ft 8½in.

Each transformer will be enclosed in a tank shaped to follow closely the contour of the three-limb winding, the tank walls consisting of cylindrical surfaces joined by a minimum area of flat surface.

Leakage flux is of the order of 29 per cent. To control this leakage flux and avoid overheating of the magnetic parts, such as core clamps and tank, a special method of shielding is being used. It consists of shielding the main core supports by cladding them in copper and by enclosing the complete transformer in an aluminium lining inside the tank.

To comply with transport limitations the transformer weight has been reduced to 290 tons (each) complete with tap-changers, bushings and coolers, ready for service ; stripped for transport each transformer weighs 154 tons. For similar reasons the clearance between the top yoke of the transformer and the underside of the cover has been reduced to 1½in.

Mechanised Car Park

Now in course of preliminary trials is a "Zidpark" being erected by Myton, Ltd., a member of the Taylor Woodrow Group, in the City of London, at the north end of Southwark Bridge. The park is constructed on the principle patented by Monsieur Andre Thaon, and in which world rights are held by Materiel Industriel S.A., whose licensees in the British Commonwealth are Matisa Equipment, Ltd., Chertsey, Surrey.

The basis of a "Zidpark" is a series of conveyors which move at right angles to the longitudinal axis of the car, so that travels are reduced to car widths rather than car engths. Each conveyor consists of separate tracks for front and rear wheels, and each track is made up of round rods carried on rollers of "Tufnol" and linked together by sprocket chain. In the present installation each conveyor is long enough to carry two cars side by side, and they are installed on the basement, ground, and first to sixth storeys of a steel frame structure. The storage conveyors are served by and driven from a lift and are built one each side of it (except on the ground floor, where access is available) so that each lift has $2[(7\times 2)+1]=30$ storage spaces of which the last one cannot be let. The Myton park has sixteen lifts, so that there is a total of $16\times 29=464$ spaces available.

The operation of the park is electrical. To each car is assigned a numbered key—the customer is given a tally bearing the same number—and the operator selects the mode of operation "Entry," puts the key in a vacant space, and presses the "Initiate" button. The lift comes to the ground floor, the doors open, and the conveyors in the lift are set in motion; these conveyors drive, by means of coarse cog wheels, the conveyors in the access space, and so the car is moved towards the lift. Sets of photo-electric transmitters and receivers at floor level observe separately the passage of front and rear wheels, and the control gear will stop the conveyor with each pair of wheels centred in the lift; one only of the tracks can be declutched from the drive, so that this may entail reversing the other track. Because of this facility, three-wheeled cars must be loaded under manual control from the local control panel seen above the bonnet of the car in the picture, a Mk. II "Consul." When the conveyors have stopped, and if the photo-electric guards each side of the vehicle are unobstructed, the doors close and the lift runs to the floor chosen by the operator. There are no doors except at the access bay, so that on arrival the conveyor starts, driving also the storage conveyor, and the car is unloaded. If one car has already been dumped on to that conveyor, it moves away to the far end as the newcomer enters. It is because such a car cannot be retrieved without moving the car nearer to the lift that the last space in the stack must be reserved for use in "Transfer" operations. For "Exit" the sequence is reversed, except that moving the car out of the lift is done under manual control. It is expected that this sequence can be performed rapidly enough to load thirty-two cars an hour; assuming no delays due to cars at one lift obstructing access to another, 250 cars could be parked in half-an-hour.

The installation is, it can be perceived, complex, and the number of working parts in a machine incorporating great lengths of roller chain is obviously indefinitely large. "Safe life" design has therefore yielded to "fail safe," so that if a chain slips round a sprocket or even breaks, the malfunction will cause the working to stop. When that part of the control mechanism which is automatic is inoperative, the park can still be operated on local control by a man in each lift. In order that the onset of such irregularities shall not go unobserved, the parking conveyors are only partly treaded, and so any tendency for them to creep out of their correct positions will be easily discerned.

[Reply Card No. E6831]

A loaded lift cage seen from the inside; notice, at floor level, the light source for the centralising system. Higher up is another photo-electric installation checking that the load is within the shaft. Notice also that the tracks of the storage conveyors are not continuous, rods and rollers being fitted only where necessary; the conveyor is based on sprocket chain

Queen's Bridge, Perth

THE Queen's bridge, now completed for the City and Royal Burgh of Perth, is the most easterly road crossing of the Tay. The previous bridge on the same site was a four-span steel girder through bridge, continuous over two of its three river piers. These piers were not sound, and the effects of river scour and traffic vibration made remedial work necessary.

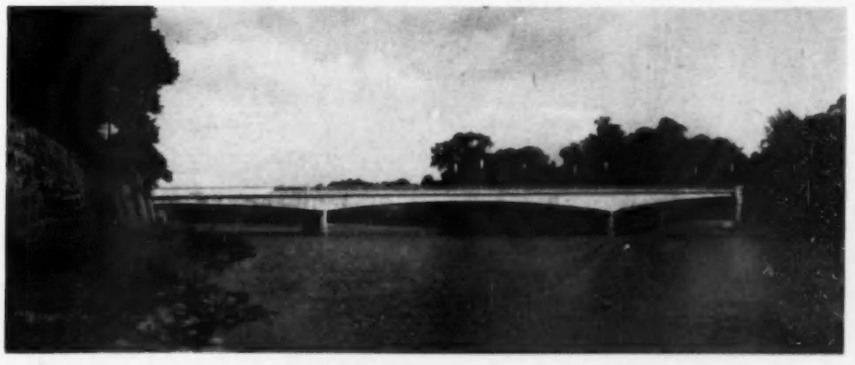
The new structure, which is 400ft long, is on the line of the old bridge and is supported by two river piers near two of the original piers, the new piers being founded on precast concrete piles. The new bridge consists of four longitudinal beams, with transverse slabs top and bottom, forming three hollow boxes side by side; it is prestressed on the Freyssinet system, and is continuous over its three spans. A reinforced concrete edge beam along each side of the roadway supports a footpath; the space between the edge beam and the main prestressed structure is used as a services duct. The central span is 187ft 5in (to the pier centres) and its structural depth is 3ft 6in at mid-span. The other two spans are about 86ft and 114ft long respectively.

Because the Tay at Perth is tidal and subject to rapid rises in level, it was decided to construct the new bridge without any scaffolding in the river. The road deck of the old bridge was stripped, leaving only the main longitudinal beams, and the transverse beams which occur at 12ft centres. This skeleton framework was then jacked up approximately 6ft on the existing piers, so that the transverse beams just cleared the road line of the new bridge. All formwork for the new bridge was then supported from the old bridge by a system of hanger rods, prefabricated plywood formwork panels being suspended from the existing transverse girders.

Work began at the two river piers simultaneously, and was carried outwards from the piers in both directions, so as to keep each section approximately in balance around its pier at all times. The prestressing cables are arranged in layers over the supports, with end anchorages at intermediate construction joints or pockets in top and bottom flanges, so that each section could be stressed and made self-supporting as it was constructed. The final closure was at the crown of the centre span. Continuity is effected by a number of cables running the full length of the bridge, supplemented by comparatively short cables, at the top and bottom, in the centre portion of the middle span.

After the prestressed roadway section had been completed, the transverse beams of the old bridge were jacked up off the new road slab, and the old longitudinal girders and their supporting river piers removed. This permitted the reinforced concrete edge beams, which lie on the line of the old longitudinal beams, to be constructed. The formwork for these edge beams was supported from the old transverse girders.

The bridge was opened to traffic after fifteen months, but finishing work and painting of the railings took a further six weeks to complete. It cost approximately £150,000. The consulting engineers were Messrs. F. A. Macdonald and Partners, and the contractor was Whatlings, Ltd.



Queen's Bridge, Perth

SHORTER REPORTS *(Continued)*

Compatible Pumps

FURTHER developments have been announced in the range of equipment manufactured by Neumo, Ltd., South Coast Road, Peacehaven, Sussex, for the pumping of fluids, particularly aggressive liquids and in adverse environments where flameproof requirements must be met. For handling corrosive acids a pump is now available in "Ferrobestos."

It will be recalled that the Neumo air motor works non-expansively (see page 400, October 9, 1959) and hence large quantities of air can be wasted by the very slow stroking of the motor when the pump has been stalled but is applying pressure and causing slow seepage past the piston packings. To overcome this waste, there has been introduced an "Automator," a device which senses the pressure in the delivery line and, when that pressure reaches the design value, cuts off the air supply to the motor. The air trapped downstream of the "Automator" will be able to hold the delivery pressure up by expansion, and if the "Automator" is set not to reopen the supply until the pressure has fallen considerably a saving in air will result. The "Automator" can be made out of p.t.f.e. in order to render it compatible with corrosive liquids.

A new pump has been evolved and styled "Supaversal"; it can not only be fixed in any attitude but also be inserted into a barrel or drum. The motor is fitted at the top, above the delivery connection, and the pump itself at the bottom of what appears to be a plain pipe, the two being separated by a delivery duct and a connecting-rod of any length to suit the application; the overall length can range from 8½in to several feet. The pump has a removable cylinder liner to facilitate building units of the desired output, and any Neumo motor can be fitted. An application which is particularly canvassed is the delivery of oils and greases to guns and nozzles.

[Reply Card No. E6841]

Launch of S.S. "Serenia"

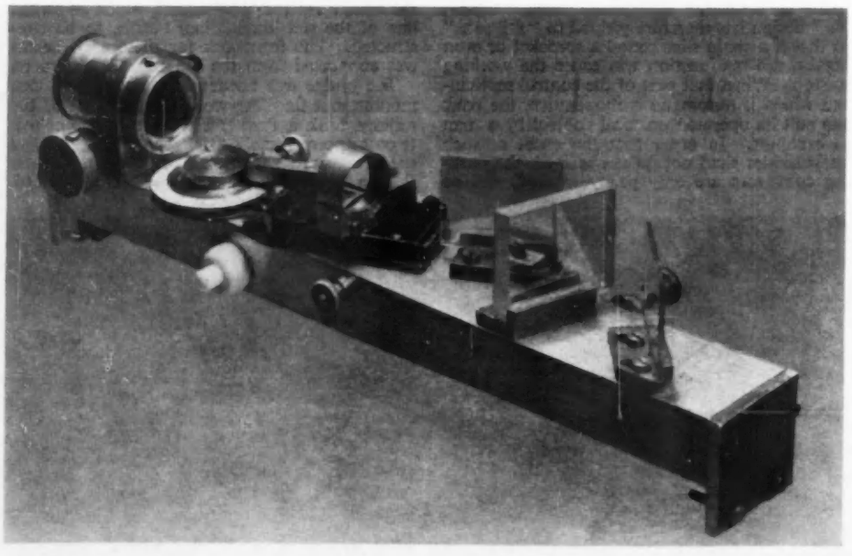
ON Tuesday, October 18, The Honourable Mrs. R. Wood, the wife of the Minister of Power, named and launched the oil tanker "Serenia" which is building at the Naval Yard, Walker, Newcastle-upon-Tyne, of Vickers-Armstrongs, Ltd. The ship, ordered by Shell Tankers, Ltd., is the largest tanker built in Great Britain and is designed to carry a deadweight of 65,000 tons on the following dimensions: length overall 817ft 9in, length between perpendiculars 775ft, breadth moulded 112ft 6in, depth moulded 57ft 9in and load draught 42ft 6in. Two main longitudinal bulkheads and associated transverse bulkheads provide a total of forty-two tanks of which thirty-three are allocated for the carriage of oil fuel, the remaining nine being reserved for water ballast. For handling the cargo oil, the pumping installation includes; four vertical centrifugal turbine-driven 1900 tons per hour pumps and three vertical duplex 200 tons per hour stripping pumps. Two vertical single-stage-turbine-driven centrifugal pumps, each rated at 2000 tons per hour will deal with the ballast water. The designed service speed is 16½ knots and this will be maintained by main propulsion machinery consisting of a single set of double reduction geared turbines developing 22,000 s.h.p. and taking steam from two Babcock and Wilcox selectable superheat watertube boilers.

Binocular Rangefinder

A BINOCULAR rangefinder which imposes no degradation of the view of the object has been invented by Mr. N. P. Barton, A.M.I.Mech.E., of the Fighting Vehicle Research and Development Establishment and is being exploited by the National Research Development Corporation. In the "3-D-3" rangefinder, instead of two images having to be brought into superposition, the object is seen normally but with an illuminated spot in the view, this image being projected stereoscopically so that it can be located in three dimensions; the range indicated by the rangefinder is the distance to the image of the light spot. An additional refinement available for use on cameras is to project three spots, the first and third appearing at the ends of the depth of forms. Conceptually, the range and depth-of-focus settings of the "3-D-3" can be coupled to the focusing and aperture controls of the camera. A further refinement is to calibrate the brightness of the images and use the device as a spot photometer. It is claimed that the new rangefinder in the hands of untrained observers yields a standard deviation of 0·6in in measuring a 10ft range, and that for trained observers the corresponding figure is 0·5in.

The principle of the rangefinder is perceptible in the demonstration model illustrated. The indicating marks are generated by diapositives mounted in the lamphouse at the far end; the large milled knob sets the "depth of focus." A virtual image of these marks at a greatly increased distance is created by the collimating lens, the marks being inside its focus. The light from the marks is shone upon the semi-reflecting mirror in the centre, that reflected meeting the left- and that transmitted the right-hand of the remaining pair of semi-reflecting mirrors. The user looks through these latter mirrors, one in front of each eye, and apart from the attenuation they impose sees the object in the usual way. The distance at which the images appear is varied by moving the collimating lens, and its travel is magnified and indicated by a cam with a scale round it. Notice that the slide on which the lens is mounted is inclined to the light path, so that as the images are moved away they appear farther apart in the paired mirrors. Another precaution against left and right eyes seeing separate images is that the distance between the pair is adjustable.

[Reply Card No. E6843]



Rangefinder projecting a stereoscopic image at an adjustable distance from the viewer: the semi-reflecting properties of the plane screens are apparent

Direct Submarine Cable to Sweden

A CABLE between Britain and Sweden opened on October 11 is the first direct telephone cable to link the two countries. Twenty-four more telephone circuits between London and Stockholm have now become available. Telex and public telegraph circuits are also being provided through the cable.

Hitherto telephone circuits between the two countries have been routed through the Netherlands and Denmark, or through Northern Germany. This new development provides a third route. The submarine cable was laid by H.M.T.S. "Monarch" and cost £1,500,000. It is a joint undertaking of the G.P.O. and the Royal Swedish Board of Telecommunications. The underwater section, which comprises 530 nautical miles of submarine coaxial cable, twenty-nine submerged repeaters, submerged equalisers and shore-based terminal equipment, was supplied by Standard Telephones and Cables, Ltd., to the order of the British Post Office. The cable was manufactured at the company's Southampton submarine cable division; terminal equipment and submerged repeaters were made at the North Woolwich plant. It runs between Gothenburg, Sweden, and Marske, near Middlesbrough, and is the longest in European waters to date using a single cable for both directions of transmission.

The repeaters used on the new cable are of the same kind as those to be supplied by S.T.C. for CANTAT, the U.K.-Canada cable which will be the first link in the proposed round-the-world Commonwealth cable. Like the CANTAT repeaters, they have a bandwidth sufficient to carry sixty two-way telephone circuits of 4 kc/s spacing.

[Reply Card No. E6844]

Launches and Trial Trips

PORT ALFRED, refrigerated cargo liner; built at Belfast by Harland and Wolff, Ltd. for the Port Line, Ltd.; length between perpendiculars 470ft, breadth moulded 67ft 6in, depth moulded to upper deck 41ft; ten passengers; three steel decks, eight watertight compartments, five main cargo holds; one 75-ton, four 15-ton, four 10-ton, six 5-ton and two 3-ton derricks; three 425kW diesel-driven generators; Harland and Wolff single-acting, two-stroke pressure induction opposed-piston oil engine, seven cylinders 750mm bore by 2000mm combined stroke, 112 r.p.m. Launch, September 8.

LANCASTRIAN PRINCE, closed shelter deck cargo ship; built by The Burntisland Shipbuilding Company, Ltd. for the Prince Line, Ltd.; length between perpendiculars 345ft 8in, breadth moulded 57ft 2in, depth moulded to upper deck 32ft 4in, draught loaded 23ft 5in, deadweight 5500 tons; twelve passengers; four holds, one 25-ton, four 10-ton and eight 5-ton derricks; three 170kW generators; Hawthorn-Doxford, two-cycle opposed-piston oil engine, four cylinders 600mm bore by 2320mm combined stroke, 3300 b.h.p. at 110 r.p.m. Trial, September 12.

INDUSTRIAL NEWS

Controls for Industry

The George Johnstone lecture, which is sponsored annually by the South Western Electricity Board in association with the Seale Hayne Agricultural College, Newton Abbot, Devon, was presented last Friday by Lord Citrine. His subject was " The place of the large scale organisation in the modern economy," and he forecast a public demand for more supervision of large, near-monopolistic, privately-owned industries, and even for public ownership of them. Large organisations were essential, Lord Citrine said, because of their resources for planning and research, but, he went on, American experience had shown that, despite very severe legislation, there had been very limited success in preventing combination and the abuse of power by large organisations.

Lord Citrine said that he hoped for better results in this country. Neither the Government nor the trade unions wanted to suppress competition, he continued, but they wanted to ensure that the general efficiency redounded to the public interest. There must be a greater measure of accountability by these companies to the public. Could there not be some parallel with the nationalised industries, he asked ; their problems were not the same but there could be some identity of interest there. His feeling was, Lord Citrine said, that something in line, in principle, with the Iron and Steel Board might provide us with a solution. The large scale organisation was an inevitable and permanent feature of our economic organisation, and, Lord Citrine added, he believed it would grow in importance. It would function under safeguards and supervision which would not stifle initiative and flexibility and would be accompanied by a sense of responsibility to the public.

Relocation of Industry

The redevelopment which the City Council of Birmingham is carrying out in the five major redevelopment areas of the city is now in the eighth stage of a twenty-phase programme. It is expected to disturb some 1300 firms. As the scheme has now been in progress for some years the public works committee has conducted a productivity survey among sixty-seven firms which now occupy flatted or unit factories built by the Corporation and premises erected by the individual firms, to assess partially the effect of its relocation policy on industrial production.

Of the fifty-five firms which actually gained from the move, it is significant the committee states, that the greatest expansion occurred in small firms having a floor area not exceeding 5000 square feet, where output went up by 50 per cent, in firms engaged in manufacturing, and in firms occupying rented accommodation. Firms building new premises for themselves, the committee suggests, had a greater capital outlay and were often unable to seize the opportunity to re-equip fully because of finance. However, these firms were generally confident, the committee adds, that the move would prove advantageous.

Physical working conditions had improved in all cases and efficient time and labour-saving layouts had been designed for the new premises. Many firms had taken the move as an opportunity to discard old machinery and replace it with modern equipment, in many cases adding production capacity for which formerly there had not been space. It had been anticipated that the increase in output per worker would rise, the committee says. but it was most encouraging to find that the increase had been approximately 18 per cent compared with the national average increase in output per worker over the same two year period of only 7 per cent.

Industrial Trends

The results of the Federation of British Industries' ninth inquiry into industrial trends were published last week. Based on the replies of 728 chairmen and managing directors of a representative sample of British manufacturing companies, the questionnaires were answered in the last week of September and the first week of October. The replies show, the Federation says, that the steady rising trend reported in the previous four inquiries, June, 1959, onwards, has continued but at a slackened pace. There are signs, the Federation adds, that industrial activity is approaching a plateau. The replies indicate that there is rather less optimism about the general business situation in the country than there was four months ago.

The shortage of skilled labour still appears to be one of the most important limiting factors on the expansion of production. On balance output has risen, but the upward margin, though marked, the survey notes, is less than reported in the last four inquiries. Total new orders are up on balance, though less so than output; 34 per cent of the replies reported that orders were " up " whilst 40 per cent said that output was higher ; 20 per cent reported that orders were " down " compared with 11 per cent " down " on output. The extent to which demand may limit output was shown in the replies to the question, where " orders or sales " were given as the limiting factor to output in 22 per cent of the replies. The figure four months ago was 15 per cent.

There has been no significant increase in export orders over the last four months the survey indicates. The rise in raw material stocks has continued. Costs are again reported to have risen for a significant sector, and with little change in selling prices, the survey shows that profit margins are again under pressure.

According to the Federation's survey, capital expenditure authorisation for plant and machinery is again expected to be higher in the next twelve months, but for new buildings the rising trend shown in the two previous inquiries this year has turned slightly downwards. The proportion of firms working to capacity has not changed, but the importance of lack of capacity as the limiting factor to output has lessened.

The replies emphasise one familiar point, the Federation says, that despite the measures taken to reduce home demand, exports have not risen to the extent necessary to support our high level of domestic activity. But they also illustrate the dilemma of our situation, the Federation adds. Some relaxation of the " squeeze " may soon be necessary if domestic demand is to be relied upon to justify the investment necessary for future growth on the other hand; the scope for a revival of domestic demand is limited by our balance of payments situation.

Fire Fighting in Factories

The Ministry of Labour announces that a letter is being sent to owners and occupiers of more than 220,000 factories in Great Britain subject to the Factories Acts, drawing their attention to the new requirements under which they must provide adequate fire fighting equipment from December 1. The order also brings into force a provision requiring fire alarms to be installed in about 10,000 more factories than are at present required to have them, and for the testing and examination of these alarms periodically, normally at least once every three months.

Other important provisions of the Act which will become effective are those transferring from district councils to fire authorities the duty of ensuring that certain factories have adequate means of escape, and empowering fire brigade officers to enter factories when authorised by a factory inspector, for the purpose of assisting the inspector on fire matters, and enabling the Minister of Labour to make regulations about fire prevention and fire fighting.

Telephone Development Proposal

The need for a plan to accelerate expansion of the telephone system in this country was urged at a press conference held by the Post Office Engineering Union on October 17. Mr. Charles Smith, General Secretary, said the union had been concerned for some time at the rate of growth of the system. How uneven this had been could be seen from the fact that the number of telephones increased by 338,000 in the year ending March, 1957, but in the following three years the annual increases had been 135,000 (1957-58), 206,000 (1958-59) and 323,000 (1959-60). The union believed that serious public attention ought to be given to a five-year plan of telephone development based on a regular rate of growth of at least 5 per cent a year. The programme which the union proposed, and which it would be placing before the Postmaster-General, would raise the number of telephones in five years from the present 8,000,000 to 10,000,000. They were convinced that this could be done with relatively little extra staff and relatively little extra capital expenditure being made available. To achieve the programme, however, the Post Office would have to use sales promotion methods more freely than it had done in the past. With its general experience of restriction of capital, the Post Office had been chary of encouraging demand for the telephone. An expansion programme would necessitate using advertisement and other forms of sales promption on a modest scale, particularly in areas where development schemes made it possible to offer service virtually on demand.

PERSONAL AND BUSINESS

Appointments

MR. GORDON ELLIS has been appointed managing director of Farrar Boiler Works, Ltd.

J. A. HEMMING, Ltd., has appointed Mr. H. Warbrick as its company accountant.

MR. PETER WHINCUP has been appointed manager of the mining division of Richard Sutcliffe, Ltd.

MR. W. H. PARRY has been elected President of the Purchasing Officers' Association for 1960-61.

MR. H. V. ROWLANDS has been appointed sales director for Burtonwood Engineering Company, Ltd.

MR. G. H. LOWTHIAN has been elected chairman of the Industrial Training Council in succession to Lord McCorquodale.

TANGYES, Ltd., announces the appointment of Mr. E. P. Bridson as sales manager responsible for both home and export trade.

SPERRY GYROSCOPE COMPANY, Ltd., states that Mr. George Orloff, M.I.Mech.E., has joined the company's industrial division as a consultant.

THE MINISTRY OF AVIATION announces that Air Vice-Marshal C. Scragg has been appointed deputy controller (R.A.F.) with the Ministry's Air Controllerate.

MR. S. F. NEWEY, A.M.I.Mech.E., A.M.I.E.E., has been appointed project engineer of the Midlands project group of the Central Electricity Generating Board.

MR. D. A. OGILVIE, A.M.I.Mech.E., drawing office manager with the parent company, Baker Perkins, Ltd., has been appointed a director of Baker Perkins (Exports), Ltd.

MR. T. H. THORNEYCROFT, a director of the Harland Engineering Company, Ltd., has been elected to succeed the late Mr. H. Cowan Douglas as chairman of the company.

TARMAC ROADSTONE, Ltd., announces the appointments of Mr. T. C. Clinch and Mr. W. E. Witchell as local directors in the southern division and of Mr. R. Smith in the central division of the company.

THE NATIONAL COAL BOARD has appointed Mr. E. Keen to be industrial relations director of the north eastern division of the Board, in succession to Mr. J. V. Curry who has resigned for health reasons.

CAPTAIN (E.) W. GREGSON, M.I.C.E., M.I.Mech.E. a director of W.G.I., Ltd., Manchester, has taken up the appointment of managing director of West's Piling and Construction Company, Ltd., a subsidiary of W.G.I., Ltd.

RICHARD SUTCLIFFE, Ltd., has announced the appointment of Mr. A. H. Holmes as secretary of the company in succession to Mr. E. Crome, who will in future devote more time to Group activities. Mr. Crome will continue as financial director of the company.

FOSTER BROTHERS (LONDON) Ltd., announces that owing to advancing years Mr. A. T. Ayers is shortly retiring from the board and his place will be taken by Mr. J. S. Derek Ayers. The firm also announces that Mr. J. H. Watson has joined the sales side of the company.

GATE MACHINERY COMPANY, Ltd., announces that Mr. J. G. Famey, Midland sales director, and Mr. A. J. Cann, technical representative for south London and southern home counties of the Elgar Machine Tool Company, Ltd., have been appointed to the company's board of directors.

GLENFIELD AND KENNEDY, Ltd., has announced the appointment of Mr. Eric Miller, A.M.I.C.E., formerly lecturer in hydraulics and hydrology at King's College, Durham University, to the post of research engineer, in charge of the company's new hydraulics laboratory at its Kilmarnock Works.

J.I. CASE COMPANY, Ltd., has announced the appointment of Mr. L. H. Hart as area representative in the four northern counties, Northumberland, Westmorland, Cumberland and Durham. Mr. Bob Dales has been appointed area representative in the counties of Warwick, Worcester, Hereford, Shropshire and Stafford.

J. BLAKEBOROUGH AND SONS, Ltd., has announced the appointment of Mr. W. L. Gibson as chief engineer. Mr. C. D. Blakeborough continues as manager of the company's nuclear and steam division, and becomes the chief assistant to the sales director, Mr. W. E. Ashley.

FIRTH-VICKERS STAINLESS STEELS, Ltd., has announced that Mr. C. E. Homstrom, a director of the company and chairman of Shepcote Lane Rolling Mills, Ltd., has retired from the boards of these two companies. Mr. J. T. W. Dewar, managing director of Firth-Vickers Stainless Steels, Ltd., and Shepcote Lane Rolling Mills, Ltd. has been appointed chairman of Shepcote Lane Rolling Mills, Ltd.

DOWDING AND MILLS, Ltd., announces that following the death of Mr. A. E. Hollings, managing director, Mr. G. A. Onion has been appointed to the board. He will be director-in-charge of the Birmingham Works and Mr. P. L. Hollings will continue as director controlling the London and Southampton Works. Mr. W. L. Henderson has been promoted to manager of the London Works with Mr. P. A. Chambers as assistant, and Mr. H. Westwood the manager of Birmingham Works with Mr. F. J. Gardiner as assistant.

Business Announcements

WINSTON ELECTRONICS, Ltd., Shepperton, Middlesex, has appointed Hawnt and Co., Ltd., 112-114, Pritchett Street, Birmingham, 6, as its Midland distributor.

PRODUCTION-ENGINEERING, Ltd., announces that it has formed a new organisation in Paris, Production-Engineering Société Anonyme, 3, Square de l'Opera, Paris, IXeme.

LONDEX, Ltd., Anerley Works, 207, Anerley Road, London, S.E.20, announces that it is the sole distributor in the United Kingdom for the electro-magnetic valves manufactured by Concordia G.m.b.H., Stuttgart.

COVENTRY MACHINE TOOL WORKS, Ltd., and WICKMAN, Ltd., announce that discussions between them have been successfully concluded and that Wickman has now delivered a formal offer to Coventry to acquire the whole of the issued capital of the company.

WICKMAN, Ltd., Coventry, states that the sole agency in the United Kingdom for the mining and construction equipment built by the Gardner-Denver Company, Illinois, U.S.A., has now been assumed by the Wickman Mining Division, Bottrill Street, Nuneaton.

DOWTY SEALS, Ltd., a member of the Dowty Group, is to set up a subsidiary in Malta to manufacture synthetic rubber seals for hydraulic and pneumatic equipment. The subsidiary company, which is to be called Malta Rubber, Ltd., will export all its output.

COLT VENTILATION, Ltd., has announced the formation of a part-owned subsidiary company in N.V. Braat en Colt Ventilatie of The Hague. The new company is a joint venture with the Dutch engineering company N.V. Bouwstoffen v/R A. E. Braat of The Hague.

CONSIDERE CONSTRUCTIONS, Ltd., announces that its offices at 72-74, Victoria Street, are being demolished early next year, and that it is moving to new offices at 66-71, Wilton Road, Westminster, London, S.W.1, on Friday, October 28, 1960. The telephone numbers Victoria 3033-4 will remain unchanged. Official permission has been given to a change of name to Considère and Partners, Ltd., which will be used in future.

ARDEX SURFACES Ltd., of 88, Crawford Street, London, W.1, has been formed to market the floor screeding compounds "Ardex," "Ardur" and "Ardurit," manufactured by Ardex Chemie G.m.b.H. of Western Germany. Mr. Percy Harris is chairman; the other directors are Dr. Ing. K. Krafft, Monsieur R. H. Guerin and Mr. J. Warren-Price, F.C.I.S. It is intended that, in due course, these products will be manufactured by Lafarge Aluminous Cement Company, Ltd., at their West Thurrock Works.

BRISTOL SIDDELEY Ltd. has announced that it has signed an agreement with Svenska Rotor Maskiner of Stockholm for the manufacture of SRM hydraulic torque convertors at the company's power division in Coventry.

Contracts

G. WIMPEY AND CO., Ltd., is to construct a bypass about 3¼ miles long at Torryburn, Fife, on the Dennyloanhead-Kincardine-Kirkcaldy-St. Andrews trunk road, at an estimated cost of £272,000. The contract will be carried out under the supervision of Fife County Council as agents for the Secretary of State.

TARMAC CIVIL ENGINEERING, Ltd., has received a contract from the Minister of Transport for diverting the Worcester–Wolverhampton–South of Stafford Trunk Road (A.449) from the village of Battlefield, in Staffordshire. The new road will be constructed on the east side of Battlefield and have dual 24ft carriageways, separated by a central reservation, which will run for just over ¼mile to the south. Staffordshire County Council (county surveyor Mr. F. Jepson, O.B.E., M.I.C.E.) acting as agent authority for the Minister, prepared the scheme.

THE GENERAL ELECTRIC COMPANY, Ltd. is engaged on an order from the British Transport Commission, valued at over £580,000, for the electrical equipment of twenty-three high-speed a.c. multiple-unit electric trains. These are designed for a maximum service speed of 90 m.p.h., and comprise fifteen four-car and eight two-car sets for express services on the Eastern Region between Liverpool Street and Clacton or Walton. This is the first order placed in this country for electric motor coach equipment to for speeds of this order. The motor coaches will be equipped with silicon rectifiers.

Miscellanea

ALUMINIUM SCRAP.—A Standard Classification and Segregation Schedule for Aluminium and Aluminium Alloy Scrap has been produced by The Association of Light Alloy Refiners and Smelters, Ltd. jointly with the National Association of Non-Ferrous Scrap Metal Merchants. Copies are available on request from the former Association at 3, Albemarle Street London, W.1.

THE INSTITUTION OF CIVIL ENGINEERS has adopted a suggestion made at a recent meeting to form a library of computer programmes. The suggestion was made when the paper "The Place of Digital Computers in Civil Engineering," was being discussed. It was pointed out that as digital computers were playing such an important role in fields of design and research, the Institution ought to establish a library of existing programmes of interest to civil engineers, the availability of which would be a valuable aid to engineers engaged in design.

CHANGES IN I.C.E. EXAMINATIONS.—The Institution of Civil Engineers announces that as from October, 1962, a number of changes will be made in Part II of the Institution examination. Three new subjects will be introduced, namely, "town and country planning"; "highway design and traffic engineering"; and "water supply, sewerage and sewage treatment." At the same time, the subject "civil engineering construction" will supersede "building construction." The syllabus of each of the new subjects has yet to be approved by the council, but the syllabus for "civil engineering construction," which was drawn up by Mr. P. E. Sleight, M.Eng., Head of the Department of Civil Engineering at Brighton Technical College, has already been so approved. From 1962 there will be two groups of papers for candidates in Part II. Group A will consist of four compulsory papers—"theory of structures"; "surveying"; "geology and soil mechanics"; and "hydraulics," plus one paper selected from the three new subjects being introduced and "civil engineering construction." At the moment "Hydraulics" is not compulsory in Group A, and from 1962 "engineering materials" will not be a subject of examination as at present. Group B will remain in effect a separate examination, but widened in scope; it will be jointly administered by the Institution of Civil Engineers and the Institution of Gas Engineers. Part I of the Institution Examination, which remains unaltered, is common to nine engineering bodies—the Institutions of Civil, Mechanical, Electrical, Municipal, Gas, Public Health, and Production Engineers; the Institute of Marine Engineers; and the New Zealand Institution of Engineers.

CONTINENTAL AFFAIRS

by Our Continental Editor

Underfloor Wheel Lathe for Railway Vehicles

AN underfloor wheel lathe for railway workshops has been developed by Wilhelm Hegenscheidt K.G, Erkelenz/Rhld, Germany, to reduce appreciably the time normally entailed in taking rolling stock out of service to remachine wheel flanges and treads. The equipment is installed in a rail pit so that a locomotive or other vehicle can be run straight on to it and the wheels in each axle in turn machined, without need for dismantling or renewing any major components. It is stated that all the wheels on a B_0–B_0 electric locomotive can be returned in an eight hour shift on these lathes. The overall design and construction of the lathe, which can be used for reconditioning wheels from 30in to 5ft 6in diameter, can be seen in the photograph and drawing we reproduce on this page.

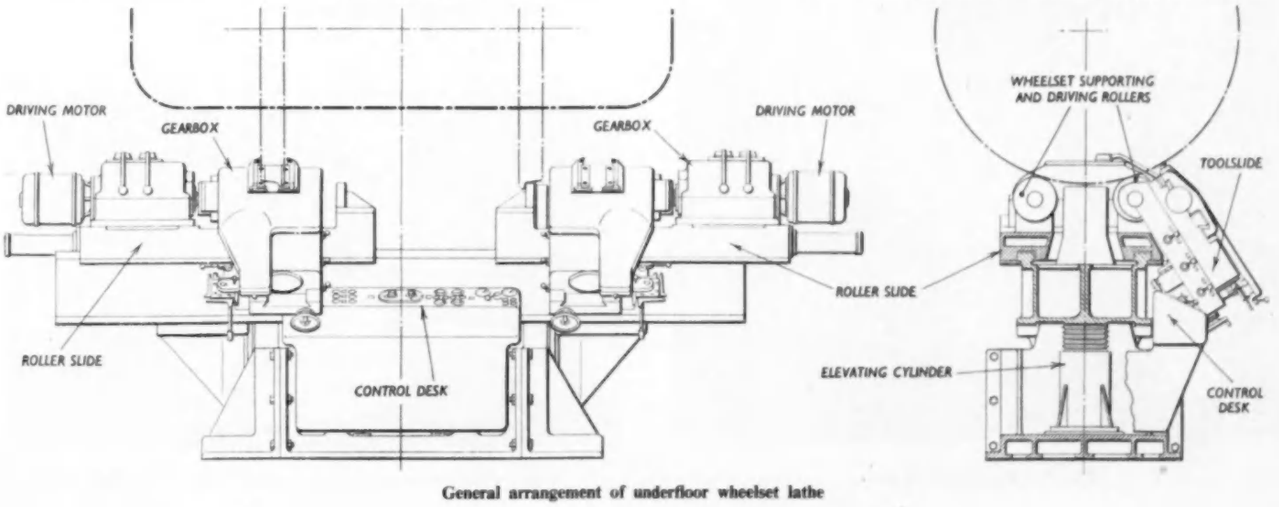
A heavy base frame supports the main bed of the machine in vertical guides. When a vehicle has been positioned over the machine the bed is raised by two hydraulic cylinders to support the wheel-set on a pair of rollers at each side. On an initial lift a bridge section of the rail track is removed and then the bed is raised and mechanically locked in the working position, with the wheels fully supported on the rollers. In this lifting movement the full weight of the vehicle is not supported by the machine but only sufficient contact pressure applied to give effective loading on the rollers to enable them to drive the wheel set for machining purposes. This contact pressure is set with reference to a gauge.

The wheel-support roller assemblies on each side of the machine are mounted on transversely adjustable bed slides and each of the four rollers is driven by an individual two-speed 7·5 h.p. squirrel-cage motor through a four-speed gearbox and transmission shaft. These driving motors are synchronised and they can only be started if all the gearboxes are set for the same speed. The rollers are carried in heavy anti-friction bearings and each is profiled to conform to the wheels to be supported and machined. Grooves in the rollers are used to support the wheels through their flanges whilst the wheel treads are being machined and adjacent sections support the wheels through their treads whilst the flanges are being turned. To bring a roller set in position on the machine the roller slides are traversed along the bed by hydraulic cylinders to position the required grooved flange or tapered tread profiles of the rollers in their working position in respect to the wheels.

During the machining of the treads and when the wheel flanges are supported on the roller grooves one of the rollers is arranged to provide also an axial support to prevent any tendency to sideways movement of the set. When a wheel set is carried through its treads on the rollers it is axially supported by two of the driving rollers, which are fitted with collars tapered at 45 deg. and maintain contact with the chamfered sides of the tyres. One of these latter rollers has a degree of axial movement on its bearings. With this ability to yield in the axial direction the roller provides compensation for any tendencies to wheel wobble during machining. The driving speeds available for turning the wheels range from 18 to 102 r.p.m.

Tool slides on each side of the bed are equipped for copy turning with hydraulic tracer control from templates on a turret head. On this turret a number of templates to cover the profiles of a range of vehicle wheels can be mounted and selected as required. These slides are traversed along the bed for the feed motion by hydraulic cylinders and a stepless range of feed speeds from 0·5mm to 1·0mm per revolution is available together with a rapid traverse motion. An electronic equipment checks and records wheel diameter at each machining operation so that

Underfloor wheel lathe in the lowered position in pit and with bridge rails inserted for the placing of a locomotive over the machine



General arrangement of underfloor wheelset lathe

CONTINENTAL AFFAIRS *(Continued)*

all the wheel sets of a vehicle are turned to the same dimensions. All the work of setting the machine and controlling the turning operations is carried out from a desk set centrally in a pit between the running rails. Dials and push buttons on the desk panel are used to determine the depth of cuts, cutting speeds and feeds, slide settings, &c.

The representative for Hegenscheidt machines in this country is the Elgar Machine Tool Company Ltd. 172–178, Victoria Road, Acton, London, W.3.

Some Exhibits from the Brno Trade Fair

FROM September 11 to 25 the Second International Trade Fair was held at Brno, Czechoslovakia. Like the first trade fair which took place last autumn this year's event was a purely technical fair. Over 3000 Czech exhibits covering the full range of the engineering industries were presented of which 10 per cent were stated to be novelties ; as well as a large number from abroad including this country. The Fair is generously laid out on an area of 520,000 square metres with a covered space totalling 66,000 square metres comprising four principal halls and several smaller buildings and an open-air exhibition of 60,000 square metres.

Among the products of the Czech machine tool industry we noted the "OFP 20" gear hobbing machine (Fig. 1) with automatic cycle, which is stated to be particularly suitable for large-scale production by virtue of a magazine with feeder which makes the production fully automatic. The cycle is electro-hydraulic with impulses derived from stops on a stop disc. The infinitely variable feeds of the hobbing slide (1·6mm to 100mm per minute) and that of the table (2·5mm to 200mm per minute) are independently adjustable. Ease of setting-up is claimed to render the machine advantageous even for short series. Gears can be machined up to 6·350 D.P. (module 4) and 200mm diameter and width. Hob speeds are arranged in nine steps from 63 to 400 r.p.m. A 9kW main motor is fitted.

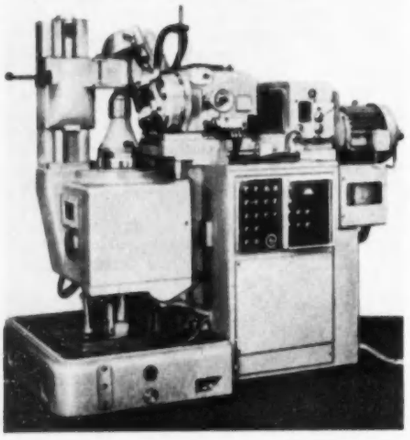


Fig. 1—"OFP 20" gear hobbing machine

The general tendency towards automatic operation was exemplified by, among others, the model "VR 4A" radial drilling machine which this year was shown equipped with an "IZS" cross table. This table consists of a bed and two slides moving mutually at right angles on anti-friction bearings. The machine has a device for automatically setting the table co-ordinates either by preselection or by punched tape programme control. When the co-ordinates have been set, the table is clamped automatically. There are sixteen spindle speeds from 28 to 2500 r.p.m. and sixteen feeds from 0·05mm to 2mm per revolution, which may be preselected or programme controlled, with programme control of the vertical movement of the spindle, and a positive stop for drilling to a definite depth. The machine has a 40mm diameter spindle with 310mm vertical movement. The distance between the spindle and the guide ways of the sleeve can be varied between 320mm and 1250mm, and the daylight between spindle and base, from 286mm to 1330mm. The arm has a vertical movement of 750mm and can be swung full circle about the column.

The tube calibrating mill (Fig. 2) comprises seven stands fitted with 400mm diameter rolls. Tubes are rolled hot (950 deg. Cent.) and the mill can accept diameters from 60mm to 140mm, and wall thicknesses from 3mm to 22mm. Tube input speeds are 0·735m to 0·955m per second, depending upon the diameter. Pressure exerted by the rolls is 13,000 kg., and two motors of 125kW, 500 r.p.m. each are fitted. A circulating lubrication system (160 litres per minute) is installed. By equipping the mill with individual 40kW d.c. motors in place of the geared drive, the speed can be stepped up to approximately 1m per second and the maximum wall thickness to 28mm.

Exhibits by the First Brno Engineering Works included a 45-ton per hour fan mill for low-grade coal, which is directly driven by a 750kW motor at 600 r.p.m. The runner has a diameter of 2500mm. The 1300mm diameter rotor of the precrusher is belt-driven at 1000 r.p.m. by a separate 50kW motor. Inlet air temperature is 800 deg. to 1000 deg. Cent. The fan mill consists of a welded grinding casing, with circumferential logarithmic spiral surrounding the overhung rotor, the grinding element proper. Plates bolted to the case form the lateral lining while the circumferential lining consists of flat bars inserted around the circumference and resting loosely on the lateral lining. The material to be ground passes from a dryer to the precrusher through an inlet gate. The supporting structure of this gate can be moved on wheels in order to facilitate opening the gate for maintenance of the fan wheel as well as of the precrusher rotor.

The CKD Works, Blansko, exhibited a hydraulic desk-type speed governor for Pelton turbines (design Professor Nechleba). The governor, model "HROP VII," is designed to operate with two out of four of its control needle valves up to 50 per cent of full generator output, and with all four needle valves above 50 per cent output. The hydraulic oil circuits for the speed control and for the servo are independent. The governor measures 1150mm by 1150mm by 120mm high and weighs 2200 kg. It can be adapted for use with Kaplan or Francis turbines.

The CKD Works, Prague, displayed a number of refrigeration compressors including the model "4 VD 260 A," for ammonia shown in Fig. 3. This has four cylinders in vee-arrangement with counterflow. The two-throw forged crankshaft is supported in the welded frame in three main bearings. On each crankpin sit a pair of connecting rods belonging to opposite cylinders. Two cylinders of 250mm bore in one row constitute the low pressure stage, and the other two the high pressure stage with a bore of 150mm, both stages having a stroke of 150mm. The compressor is directly driven through a flexible coupling at 730 r.p.m. by a three-phase, 82kW induction motor mounted on the same base. The refrigerating capacity of this machine is quoted as 115,000 kcal per hour working between

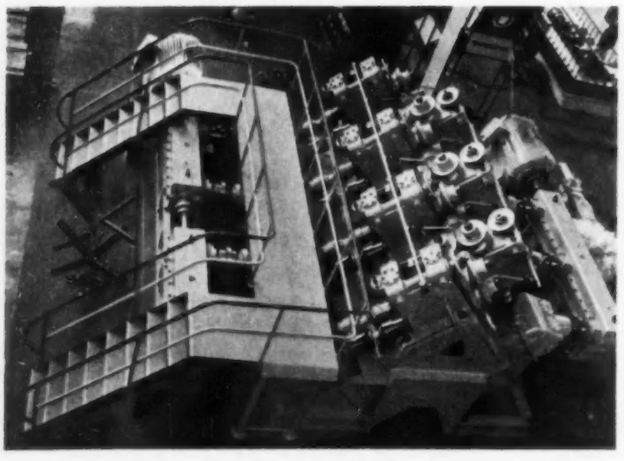


Fig. 2—Tube calibrating mill

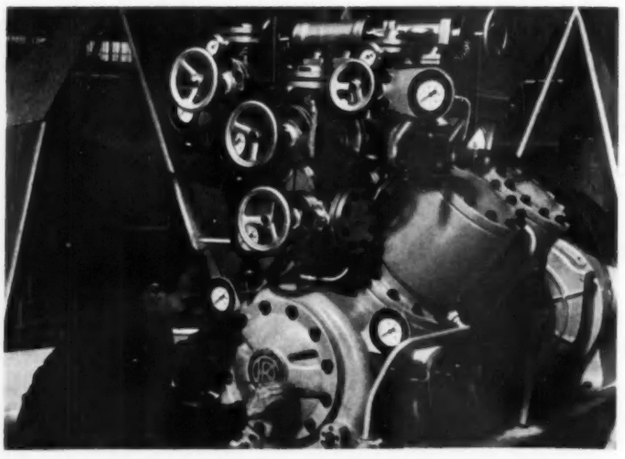


Fig. 3—Refrigeration compressor model "CKD 4 VD 260A"

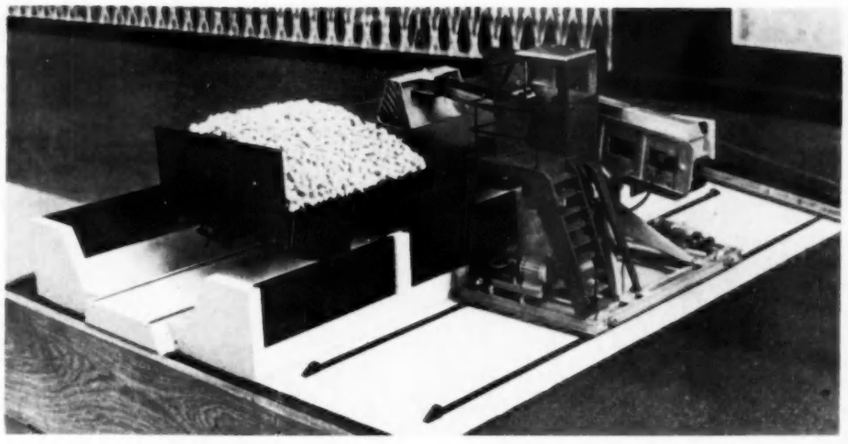


Fig. 4—Model of raking machine for discharging 120 tons of sugar beet per hour

Fig. 5—Air-blast circuit breaker for 380kV

−35 deg. and +35 deg. Cent. Machines of this design are made with up to eight cylinders, also for " Freon 12 " and " Freon 22."

An important field of effort for many years has been the development of machinery for all stages of the sugar industry. Current shortage of agricultural labour makes it imperative to mechanise as much as possible the annual beet " campaign." The Skoda Works in Hradec Králové has developed machinery for the loading and unloading of beet which was shown in model form at Brno. In Fig. 4 may be seen a travelling raking machine with an hourly capacity of 120 tons, for unloading railway wagons with removable or flap-down sides. The beet drop into a hopper under the track from where they are removed by a conveyor belt. The machine is hydraulically operated, with interlocked controls. Both forward and return stroke of the shovel are working strokes.

The handling of beet is usually carried out in the " semi-wet " state except under conditions of continuing frost when the beet are handled dry. A model showed a semi-wet plant capable of unloading, washing, and stacking 200 tons per hour. Beet are unloaded from wagons, lorries and trailers into washing machines and then pass through leaf and straw catchers on to a lifting conveyor where washing water and unusable fragments up to 10mm size, or pulp, are removed. The transport which follows is already without water. Substantially cleansed beet and roots which can be processed proceed through a separating screen to the main conveyor. Roots larger than 10mm are screened out and separately loaded or added to beet to be washed for processing. Beet are removed from the stock-yard by water jets which swill them into flumes and into the washing machine. Such hydraulic handling avoids injury to the beet and the resulting losses. The equipment, it is stated, can also be adapted for the dry method, or a combination of the two.

Also exhibited was a 65kW, 50 to 1450 r.p.m., sugar centrifuge in which the complete cycle was automatic with the exception of the charging operation. The centrifuge drum has a diameter of 1220mm, a height of 580mm, and can hold a charge of 450 kg.

A large proportion of exhibits were concerned with the chemical industry. Among other items we noted a 200-litre vibrating mill directly driven and operating at a frequency of 2880 cycles per second. The dimensions of this machine are : length, 2500mm, width 800mm, and height 1100mm ; the weight is 2000 kg. Such mills are used for the trituration of special cements, certain kinds of foodstuffs, colours and other chemicals, as well as in connection with metallurgical processes. The high proportion of grinding charge (steel spheres and cylinders) to material (70 : 30) ensures an almost complete grind to the final size which is below 1 micron (0·001mm). The capacity of the machine, which works continuously, is stated to be 2400 litres per hour.

A prototype plastic extrusion machine developed by the Buzuluk Works at Komárov was exhibited in connection with a semi-automatic line for the production of polyethylene bags. The extrusion machine is characterised by having a double worm comprising two concentric parts. The hollow outside worm has an outer as well as an inner thread. The inner worm is concentric with the other and is separated from it by a liner which extends from the nozzle end rearwards over almost its whole length, leaving only the last thread uncovered. The plastic material is drawn from the hopper and pushed forward by the outside thread of the outer worm, passes round the front end and returns by way of the inside thread. It is then extruded forward again by the central worm which has a diameter of 60mm. The arrangement leads to a great saving in length which amounts to only 1200mm, or 1400mm including the nozzle. The drive is from a 13kW motor through infinitely variable gearing, to give worm speeds of 20 to 120 r.p.m. controlled by a tachodynamo and tachometer. Heater elements of 3kW are fitted and the temperature is stated to be controllable to within 1 deg. Cent. over the range 20 deg. to 300 deg. Cent. The hopper holds 50 litres and the machine has a maximum hourly output of 80 kg.

Heavy current electrical products were represented by a three-pole airblast circuit breaker for 380kV, 15,000MVA break capacity (Fig. 5). Made by the Skoda Works, Plzeň, it is arranged for optional single-pole reclosing. The same maker introduced a 380kV isolating switch for a current rating of 1250A, and an instrument transformer for the same voltage.

In the open air exhibition were to be seen a number of railway exhibits, including electric locomotives, trainsets, and passenger and goods vehicles. A rail-mounted mobile power plant was shown equipped with a two-shaft 2·5MW gas turbine. The plant is housed in a single vehicle, with a total weight of 117 tonnes including 4000 litres Bunker " C " fuel. The generator is rated at 3125kVA, 6·3kV, at 3000 r.p.m. Inlet temperature to the high-pressure turbine is stated to be 650 deg. Cent., and the efficiency of the cycle, which incorporates a heat exchanger, is quoted as 19·2 per cent. The power plant can be towed at a maximum speed of 100km per hour.

The Rance Tidal Power Project

By J. H. M. SYKES

IN THE ENGINEER for July 13 1956 (page 54 *et seq.*) the present writer gave some details of the Rance tidal power project of Electricité de France which at that time had been fully described in papers presented to a Study Session of the Société Hydrotechnique de France, and which, it was thought, was about to be constructed. In fact, the writer said at that time that work had just started on the dam across the River Rance, which is to be situated about 2·17 miles south of the port of St. Malo. However, a little later a restriction of capital expenditure caused the preliminary exploration work that the writer saw in progress on the dam emplacements at both sides of the river to be suspended. News has just come to hand that a modified scheme for the Rance tidal power project has now been finally approved by the French Government, and work will be recommenced this Autumn.

The original scheme was for thirty-eight generating units each of 9000kW, and the amended project as illustrated on page 690 is now to employ twenty-four units each of 10,000kW, running at 93·75 r.p.m. These will be the same bulb-type units as mentioned in the earlier article, and will operate in a completely enclosed shield or nacelle, within which there will be a slight degree of pressurisation, up to 14 lb. per square inch above atmospheric pressure. In addition, there will be six sluice gates, of 50ft by 32ft, to assist in the filling or draining of the reservoir created by the dam, which is unchanged in length and situation. There will be one lock, for the passage of the small boats which sail up the River Rance, and this lock will have dimensions of 213ft long by 42ft wide.

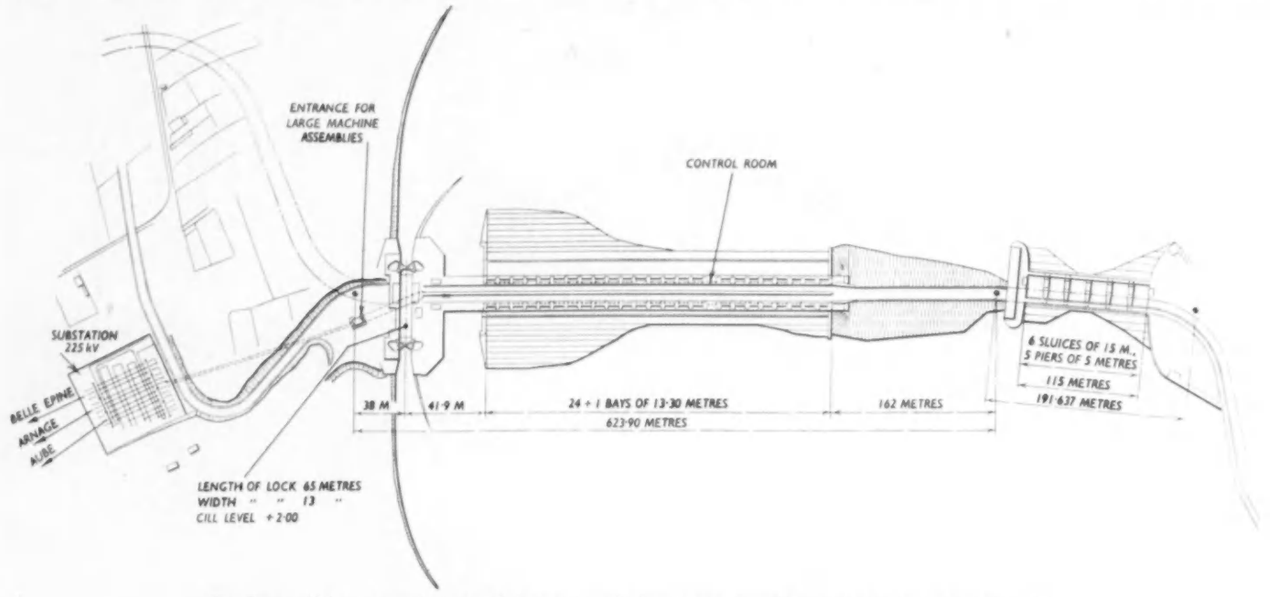
The cost of the new project will be 395·25 million New Francs, compared with a cost of 500 million New Francs for the original scheme. There will be a barrage section in the new project which can ultimately be changed to provide for additional generating units in the future.

It is perhaps worthwhile recapitulating the particular advantages of this project, when compared to any previous schemes for utilising power. Broadly, it enables peak power to be delivered to the system at whatever time the peak may occur, irrespective of the tidal state, providing pumping energy can be borrowed from the system as required.

The bulb generating units can be used to perform three functions : generation, pumping or valving, with the feathering blades in the fully open position.

In the previous article the present writer set out the modes of operation of the scheme. Starting from high tide the turbines may be used as pumps if energy is available, i.e. if it is an off-peak period, to fill the basin to a higher

CONTINENTAL AFFAIRS *(Continued)*



The Rance tidal power project, amended recently, will have twenty-four 10,000kW bulb type generating sets

level than the top tidal mark. Next, as the tide falls away on the outside of the dam, the turbines can be used to generate power ; when the head has fallen too low for power generation, the turbine blades are feathered to act as valves to accelerate the flow of water to the seaward side. The turbines can then once more become pumps and provide an artificially low level of water within the basin. The tide will now have started to rise, and as the water in the basin is artificially low, generation can take place once again, this time with the water flowing from the sea to the estuary. Once this level becomes too low for generation, the turbines are again feathered, so that they act as sluices. The cycle, with variations of timing to suit the available energy from the network for pumping, and the energy required from the tidal scheme, is repeated with each of the two tides in the day, and so on continuously.

The earlier scheme would have provided 800 million kWh per annum, but the later scheme, with reduced capacity, is envisaged as producing 567·5 million kWh per annum. However, the important feature of the scheme is that its designers are prepared to guarantee a peak output when most needed. They say that during the 1200 hours of peak demand in the three winter months—December, January and February—they can always provide firm peak power, whenever the peak occurs, of 96·8MW. During the 300 hours of top peak demand during these months, they say they can provide 194·5MW at any state of the tide.

The project will involve some 400,000 cubic metres of earth work, and 296,000 cubic metres of concrete.

Re-Railing Equipment

We have received details of the Lukas hydraulic re-railing equipment for locomotives and other rolling stock, made by Frieseke and Hoepfner G.m.b.H., Erlangen-Bruck, German Federal Republic. Our illustration (Fig. 1) shows the equipment in use. It comprises a 3·25m-long light metal box girder weighing 190 kg which supports a light metal telescopic jack weighing 63 kg. The jack can lift up to 130 tonnes with the large lower piston and up to 60 tonnes with the upper piston, the total effective lift being 490mm. Mounted on a roller base weighing 58 kg, the jack can be shifted sideways by hydraulic pressure. For this purpose the ram of the horizontal cylinder carries an extension with a pawl which engages in slots spaced along the centre line of the girder top flange. Movements are controlled by one man from a control table (partly visible in the illustration).

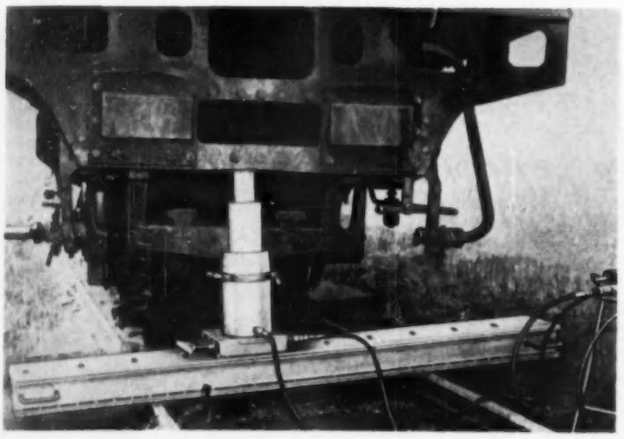
Hydraulic pressure of up to 450 kg per square centimetre is generated by a pump unit driven either by a 7·3 h.p. petrol engine or a 4kW, 1500 r.p.m., three-phase motor.

The bridge girder is designed to be transported by four men by means of handgrips at the ends. A similar girder but 4·4m long and weighing 245 kg, can be handled by six men. These girders can carry up to 60 tonnes without any special foundations between the rails.

A second kind of lifting jack weighs 59 kg and has a stroke of 160mm. This is designed to lift in stages, having a shoulder under which support blocks are placed while the ram is retracted for the next lift for which a centre block is inserted.

For righting rolling stock which has overturned on its side, a further type of jack is available which has a lifting capacity of 40 tonnes and gives a lift of 800mm. This jack may be used piston downwards, when it can be hooked under the wagon frame by means of a claw at the top of the cylinder. In that case only 120mm of floor space are stated to be required.

Alternatively, as shown in Fig. 2, the jack is used the right way up, standing on a piece of timber to spread the load. Special double straps are used which incorporate a number of rungs. On reaching the top of the first lift, a second set of jacks is placed under the next set of rungs, and the lifting continues.



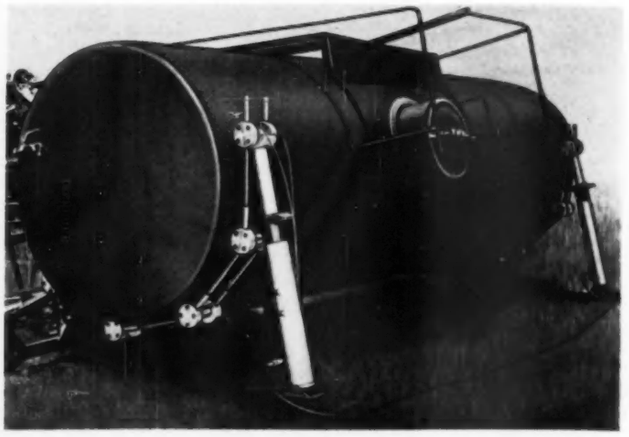


Fig. 1 (left)—Re-railing a locomotive by means of a hydraulic jack, mounted on a movable base on a lightweight girder. Fig. 2 (right)—Righting of tank wagon using hydraulic jacks engaging with support straps. At the end of the first lift, a second jack is placed under the next rung of each strap

THE AMERICAN SCENE

by Our American Editor

Construction of New N.B.S. Laboratories in Maryland

WITHIN the next twelve months, the National Bureau of Standards will break ground at its new site 20 miles from Washington, D.C., at Gaithersburg, Maryland, and start construction of the first three buildings in its new laboratories. Planning for the new laboratories has been under way since the summer of 1958, when Congress appropriated funds for architectural work. The Public Buildings Service of the General Services Administration, which is responsible for the construction programme, expects to award the first contracts toward the end of this year.

The two laboratory buildings to be started in the coming year, Engineering Mechanics and Radiation Physics, are being given priority because of the urgent need for expansion of these research programmes. This expansion involves the installation of large equipment in specially designed structures. Funds for these laboratories, the scientific equipment, the site development, and the power plant which will serve the entire new facility, were made available on July 1, 1960, in a Congressional appropriation of 23·5 million dollars. When completed, the new "campus" will have twenty buildings housing new research facilities as well as all of the Bureau's present activities. The total cost of the new laboratories, new equipment and moving of present equipment, is expected to be about 104 million dollars.

For several years now, the Bureau's vital services to national defence, military research, and industrial technology have been greatly hampered by inadequate and outmoded research facilities. Many of the buildings on the present site are temporary, and even the permanent buildings are outmoded. Renovation and modernisation would be costly, amounting to more than half the estimated cost of a complete new laboratory. In addition, some of the facilities contemplated could not be built on an urban site such as the Bureau's present location in Washington. Space for further expansion is also lacking at the present site. As a result of the rapid expansion of technology and the growth of scientific research, the Bureau's responsibilities have greatly increased. Extensive programmes of research and development must now be conducted in the physical sciences and engineering to meet the needs of science and industry for new and improved standards and measurement methods. The new site will enable the Bureau to plan and conduct a more up-to-date programme consistent with its increasing responsibilities.

The rural location will remove the Bureau's work from the variety of mechanical, electrical, and atmospheric disturbances present in a city and will reduce the effect of these factors on precise scientific measurements. In addition, the new site will provide a rural location where scientific work can be undertaken with a minimum of interference to community life. A tract of approximately 550 acres of land near Gaithersburg, Maryland, was acquired four years ago. The completion of the Engineering Mechanics Laboratory and the power station is expected in the winter of 1962. The Radiation Physics Laboratory is scheduled for completion in the spring of 1963.

Engineering Mechanics Laboratory

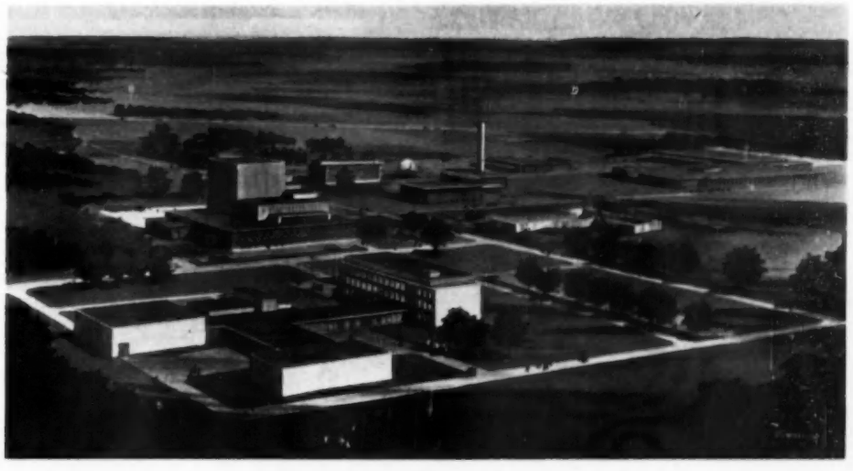
The Engineering Mechanics Laboratory is a specially designed building which will house large capacity compression and tension testing machines, dead weight machines, offices and general service space. These new calibration facilities for force-measuring devices are urgently needed in missile and rocket development programmes to supply the accurate determination of the rocket thrust and of missile load which are so critical at the early launching stages of a missile flight : they will also be of great value to other industries.

A new compression and tension testing machine of at least 10,000,000 lb capacity which requires a working height of 80ft will be situated in the largest area of the laboratory. This will be a replacement for the Bureau's present 50-year-old machine which provides compression measurements only. An area of 2500 square feet with a 20ft clear height is being prepared for the horizontal testing machine which is capable of exerting 2,300,000 lb in compression and 1,150,000 lb in tension. Final designs are being completed on dead weight machines of 300,000 lb and 1,000,000 lb capacity which will also be situated in this building. The Bureau will then be able to calibrate force measuring devices up to 1,000,000 lb by applying test loads accurate to 0·005 per cent. The present dead weight machines extend only to 11,000 lb, making it impossible to achieve high accuracy when calibrating very large devices.

Radiation Physics Laboratory

The Radiation Physics Laboratory will be a complex structure with a gross area of approximately 155,000 square feet in four levels below and three above grade. The building will house the Radiation Physics Division with its extensive activities in neutron physics, radiation theory, radioactivity, X-rays, high-energy radiation, nucleonic instrumentation, and radiological equipment. This laboratory will also house the high-intensity electron accelerator now being designed for the Bureau. This linear accelerator will produce one of the world's most intense high-energy electron beams—a beam with energies continuously variable from 10 MeV to 100 MeV and power outputs of the order of 40kW. This power output is about 100,000 times that now obtained in this range at the Bureau.

The linear accelerator ("Linac") will be placed in a narrow room 140ft long with a magnet room at the end and three measurement rooms situated radially around the magnet room. The electron beam from the "Linac" will be controlled by the magnets and deflected into one of the three measurement rooms. Shielding for the magnet room is provided by 12ft thick concrete walls and interlocking concrete doors. The other rooms will not require elaborate shielding since they are peripheral rooms 40ft underground. Each of the measurement rooms and the magnet room require 10-ton to 20-ton cranes to manipulate equipment and shielding blocks.



Artist's rendering of new site of the National Bureau of Standards at Gaithersburg, Maryland, Radiation Physics Laboratory in foreground

The sub-basement level will contain the "Linac" complex, maintenance and experimental set-up laboratories for the "Linac" several X-ray research laboratories, a cobalt-60 source pool and 1000 curie sources of cobalt-60 and caesium-137. The basement level will house the Bureau's 50 MeV betatron, 180 MeV synchrotron, 3 MeV and 1·5 MeV electron accelerators and the 2 MeV Van de Graaff positive ion accelerator. Space is planned on this floor for a variable energy, 40MeV cyclotron, to be acquired at a later date. The first floor will contain the upper level of the betatron, synchrotron, and cyclotron rooms, as well as other laboratories and offices. A three-storey general-purpose wing at the opposite end of the building from the accelerators will contain offices, conference rooms, and some laboratories. Also included in the structural features of the building are provisions to permit its use as a fall-out shelter for approximately 1500 persons.

The size and topography of the new site make is possible to have four time-of-flight tubes—

THE AMERICAN SCENE *(Continued)*

100m, 200m, 300m, and 800m in length—in connection with the laboratory. The time-of-flight tubes would be used to measure neutron cross sections and to measure the energy spectra of photo neutrons. The 1·4 MeV transformer-rectifier accelerator now being used at the present site will be replaced by a 3 MeV electron accelerator and a 1½ MeV electron accelerator. Other new equipments to be installed in the building include beam pulsing equipment for the 2 MeV positive-ion Van de Graaff accelerator, a precision beta-ray spectrometer, four multi-channel pulse height analysers, and a gamma ray source and container. A 500kV X-ray set will be moved from the present site, together with a number of X-ray sets of 250kV and lower energy.

Flexible Laboratory Buildings

More than half the total laboratory space is designed for multi-purpose use to meet the general requirements of physics, chemistry, and engineering research. There will be seven general-purpose laboratories containing a total of 556,000 square feet. Funds for these laboratories have not yet been provided. The basic building plan is rectangular, composed of three floors containing 112 laboratory modules on each floor—sixty large modules back to back in the centre of the building and fifty-two small modules on the perimeter. The size of the large modules is 11ft by 24ft ; the small ones are 11ft by 16ft. Movable steel partitions will be installed to sub-divide the laboratory areas. A room may be a single 11ft module or multiples of 11ft, depending on the requirements of the work. Laboratory services are available at service enclosures every 11ft and will be distributed into the laboratory as required along the partitions or in floor trenches.

High-Power Particle Accelerator

RADIATION Dynamics, Incorporated, of Westbury, New York, recently developed and is now manufacturing a line of particle accelerators—both electron and positive ion—especially suited for irradiation processing. The characteristics which make the so-called " Dynamitron " accelerator particularly attractive for irradiation purposes are its constant-potential, large-current output ; the rugged construction and consequent industrial reliability ; and the low cost per kilowatt of output. As shown in Fig. 1 the basic circuit of the " Dynamitron " is a set of cascaded rectifiers capacitively coupled to a powerful radio-frequency oscillator with a frequency of 300 kc/s. Two large electrodes just inside the cylindrical outer tank draw power from the oscillator and induce a radio frequency potential in a set of corona rings just inside the electrodes, as shown in Fig. 2. Thus, direct current flows through the stack of rectifiers to establish a large d.c. potential at the output.

An advantage of operating at radio frequencies is that the " Dynamitron " requires no large capacitors to store energy between cycles and to smooth output. Consequently, the static energy storage is not significantly greater than in electrostatic machines ; accidental spark breakdowns are not violent and do not damage the rectifiers or the beam tube. A large toroidal coil is connected in parallel with the driving electrodes ; electrodes and coil function as a resonant tank circuit.

The basic accelerator is made up of a voltage generator, accelerator tube and ion source. The voltage generator assembly, consisting of a cascaded rectifier stack and associated corona rings, voltage divider, high voltage terminal, driving " dee's " and toroidal coil, is mounted in a pressurised, water-cooled steel vessel conforming to ASME Code requirements. The accelerator tube is an assembly of metal aperture plates separated by glass spacers and is mounted in the centre of the rectifier column. The ion source is attached to the high voltage end, and the vacuum pumps and beam extension system are grounded. The ion source is a modified duo-plasmatron source which consists of a gas discharge chamber, cathode, anode with tungsten aperture and magnetic focusing grid. The emergent beam is converged with an Einzel lens mounted between the source and the beam tube.

Two separate oscillators are provided in the " Dynamitron " system ; one is the main driving source for the high-voltage column and the other is the power source for the ion source. All components of the oscillators, with the exception of the toroidal coil and " dee's " are contained in separate steel cabinets. The control console which houses the operating controls provides additional space for magnet controls. These controls include the basic operating meters and switches for the high-voltage supply and the ion source, as well as such monitoring circuits as oscillator plate voltage and current, grid current driving potential and vacuum. Safety interlock circuits immediately indicate any malfunction. All necessary electrical circuitry to perform the monitoring functions are housed in the console, which is illustrated in Fig. 3.

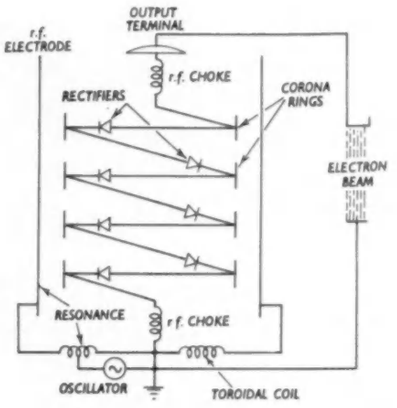
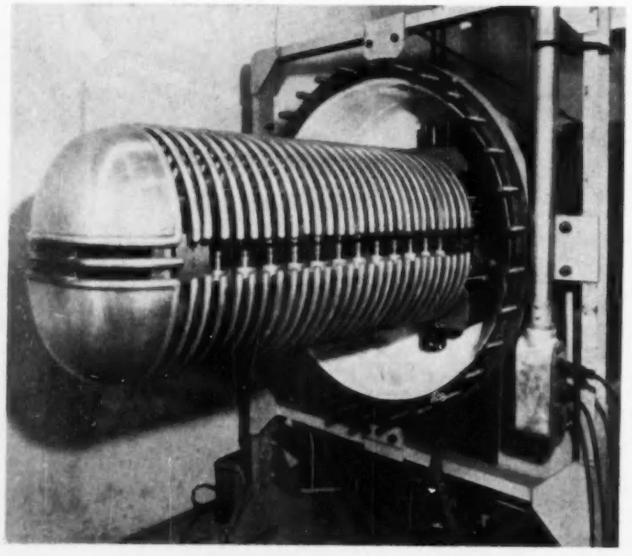


Fig. 1—Circuit of particle accelerator with r.f. drive coupled to rectifiers by the corona rings

The driving radio-frequency oscillator is a conventional highly reliable modified Hartley type. The unit is separately housed in an air-tight, water-cooled enclosure and connected by cable to the d.c. generator, which contains the oscillator tank circuit. A high-pressure gas dielectric (SF^6) between the resonant circuit and the rectifiers provides d.c. insulation and radio frequency coupling. Along the axis of the system runs an evacuated acceleration tube, which for electron acceleration has a tungsten cathode at its high-voltage terminal. For positive-ion acceleration the potential is reversed and a " Dynamag " ion source replaces the cathode.

The " Dynamitron " accelerators are of relatively new design. The first operational unit went " on stream " in July, 1959, for customer irradiation work at the firm's own irradiation service centre. In December, 1959, the service unit went on a two-shift basis. With its on-and-off requirements, service irradiation offers the severest punishment one can anticipate. Nevertheless, the accelerator unit has been performing steadily. The simplicity of design, freedom from moving parts and the use of over-rated commercial components all contribute to this performance.



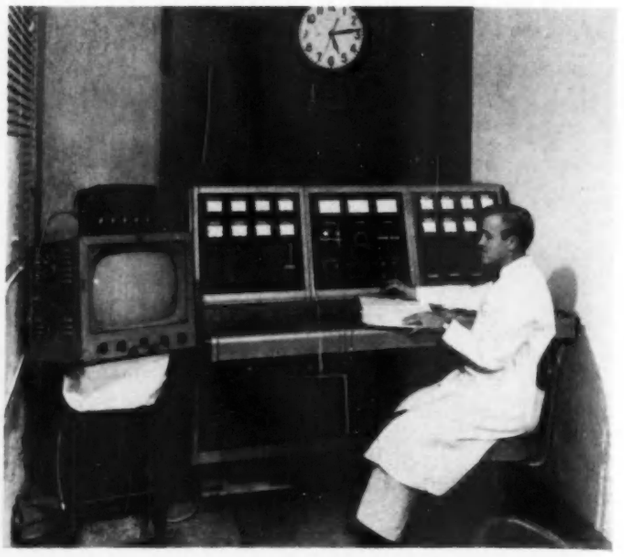


Fig. 2 (left)—Interior of " Dynamitron " accelerator with corona rings and high-potential cap on the outside and beam tube running along the central axis. Fig. 3 (right)—Control console of the particle accelerator and monitor set of the closed circuit television

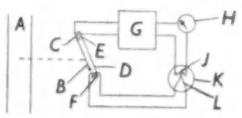
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRONICS

847,863. February 21, 1958.—TRANSDUCER, Fielden Electronics, Ltd., Paston Road, Wythenshawe, Manchester 22. (*Inventor: John Ernest Fielden.*)

This invention relates to means for converting an input signal, which may be either a mechanical displacement or an electrical potential, into an output current and has for its object the provision of novel means for providing an output current proportional to the square root of the input signal. The embodiment shown is arranged for providing an output



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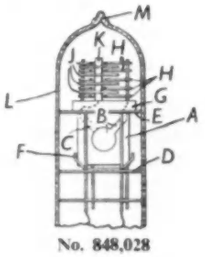
current proportional to the rate of flow of fluid in a pipe line *A*. A venturi tube or the like (not shown) is inserted in the pipe line and the pressure differential obtaining across it is caused, in known manner, to displace a measuring member *B* through an angle proportional to that pressure differential. The measuring member *B* is pivoted at one end and carries at its other end a first condenser plate *C*. An arm *D*, carrying at one end a second condenser plate *E* is mounted upon the coil *F*, of a moving coil instrument movement, the coil being arranged to pivot about the same axis as does the measuring member, and to be deflected through an angle proportional to the current flowing through it. The condenser plates *C*, *E* together form a capacitance which is connected to an oscillatory circuit (not shown) forming part of a circuit means *G*, this capacitance controlling, in known manner, the amplitude of oscillation in the oscillatory circuit, and providing, in known manner, an output current dependent upon the amplitude of oscillation. This output current is indicated by means of the indicating device *H*, the scale of which is linear with respect to current. This output current passes through the heating element *J* of a thermojunction *K* the thermocouple element *L* of which is connected across the coil *F*. The passage of current through the heating element causes a potential to be developed by the thermocouple element and this potential causes a current to pass through the coil. The arrangement thus forms a closed servo-loop and is arranged to maintain substantially constant the displacement between the condenser plates *C*, *E*. Provided that the sensitivity of the device *G* to change in capacitance between the plates *C*, *E* is high, variations in the displacement between the plates under steady state conditions may be disregarded. The current passing through the coil *F* is thus proportional to the angular displacement of the first condenser plate *C* and this is, in turn, proportional to the pressure differential. The current passing through the coil *F* is, however proportional to the square of the output current of the circuit means *G*. It follows that the output current of the circuit means is proportional to the square root of the pressure differential, and, as the rate of flow is also proportional to the square root of the pressure differential, the output current of the circuit means is directly proportional to the rate of flow. As the indicating device *H* has a scale which is linear with respect to current its scale is linear with respect to rate of flow also.—*September* 14, 1960.

848,028. December 24, 1957.—PIEZO-ELECTRIC CRYSTAL UNITS, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, London, W.C.2. (*Inventors: Donald Fairweather, John Rowsett and Norman John Beane.*)

This invention relates to quartz and like piezo-electric crystal units and has for its object to provide improved crystal units having resonant frequencies which are, to a high degree of precision, of desired predetermined values. It comprises a piezo-electric crystal unit consisting of a hermetically sealed envelope and, mounted therein a piezo-electrical crystal and an adjustable trimmer condenser to the crystal. The trimmer condenser may be a variable condenser as ordinarily understood—i.e. a condenser with electrodes which can be moved with relation to one another to vary the capacity—or it may be a condenser with fixed electrodes and which is adjusted to a desired value by building up the area of one of the electrodes—for example by depositing gold or other suitable metal by vapourisation—until a required trimmer capacity is reached. An embodiment in which a trimmer with relatively movable electrodes is used is shown in the drawing. A crystal wafer *A* of usual known form and having deposited electrodes and electrode connectors *B* and *C* is mounted in known manner between mica or like support discs *D*, *E* by means of a slotted corner supporting springy member *F*. Above the crystal wafer and fixed to the disc *E* is an insulating block *G* on which is mounted an adjustable trimmer condenser shown as a miniature condenser of the interleaved vane type with air dielectric, though other forms of adjustable condenser with air or solid dielectrics may be used. The particular condenser shown has fixed approximately semi-circular vanes *H* constituting the stator and rotor vanes *J*, also approximately semi-circular, carried on a rotatable spindle *K* having a slotted upper end to take a screwdriver. The position of the condenser is such that the slotted end of the spindle is conveniently accessible through the exhaust tail of the envelope before the tail is sealed off. As almost the last step in the manufacturing process, the trimmer condenser is adjusted until the whole unit (crystal and condenser) will present the required resonant frequency as closely as possible when the unit is pumped out, taking into account the known changes which will occur due to



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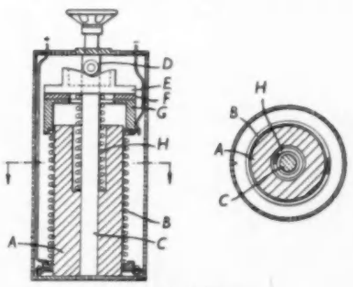
removal of air on pumping out. After pumping out, the exhaust tail is then sealed off leaving a "pip" at *M*. It has been found possible with the construction shown to bring down the so-called adjustment tolerance to $\pm 5/10^6$ or better; indeed it appears possible to bring it down to as little as $\pm 1/10^6$ or thereabouts. The invention is not limited to units in which the trimmer condenser is in parallel with the crystal, for in the case of a series resonant frequency the trimmer condenser may be in series therewith—*September* 14, 1960.

ELECTRICAL ENGINEERING

847,839. April 5, 1957.—INFINITELY VARIABLE CURRENT CONTROLLERS, VEB Schwermaschinenbau Verladeund Transportanlagen, 34 Lutzowstrasse, Leipzig N 22, Germany. (*Inventors: Siegfried Forste, Peter Schroter and Lothar Harms.*)

This invention relates to infinitely variable current controllers and is particularly applicable to controllers for electrically powered vehicles but is not limited to such application. Infinitely variable vehicle controllers based on the principle of the variable carbon contact resistor have already been proposed. They

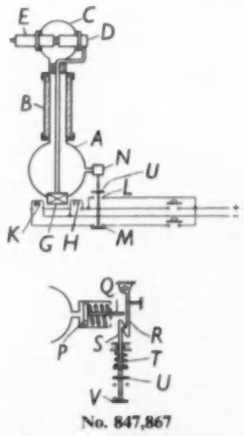


No. 847,839

operate by the compression of contacting thin carbon rings of special type. However, these carbon rings are liable to give constant trouble because after having handled considerable amperages for some length of time they fuse together. Consequently such vehicle controllers are suitable only for lighter and medium powered vehicles. The invention seeks to overcome these drawbacks and to provide infinitely variable current control means that are suitable for application to a large variety of purposes. According to the invention the problem is solved in that one or several resistors each embodied in resistance wires wound helically on a non-conductive cylindrical core are so arranged that the helices can be compressed from an initial position in which the individual convolutions of the helical wires are not in mutual contact into a final position in which they form resistors embodied in closely packed cylinders. A controller shaft carries cam elements by means of which the helices formed by the resistance wires are compressed and which also effect the short-circuiting of the resistor as well as the reversals of the direction of travel. An embodiment of the invention is shown in the drawing, wherein *A* is an electrically-conductive hollow cylinder and *B* a helically wound resistance wire. Rotary motion of the controller shaft *C* is transformed by the pressure roller *D*, cam member *E*, thrust plate *F* and the thrust cylinder *G* into an axial thrust which is applied to the helically wound resistance wire and varies the length of the helix. Spring element *H* pushes the helically-wound wires back into their initial position during braking. In the initial position of the controller the convolutions of the wire helix are not in mutual contact. However, as the helix is gradually compressed the convolutions come into contact. Part of the current will therefore now flow across the convolutions so that the effective resistance will become correspondingly smaller, whereas at the same time the current capacity of the resistor will rise because the effective cross-section increases. Further compression reduces the contact resistance between the individual convolutions until finally the resisting element will be embodied in a compact cylinder with a very low final ohmic resistance. Preferably the resistance helices are immersed in oil to cool the wire or to take up some of the heat. Another arrangement illustrated in the specification employs several cams on the controller shaft, some of which compress the helices when the shaft is rotated, while a further cam closes contacts to short-circuit the helices when they are fully compressed.—*September* 14, 1960.

847,867. March 14, 1958.—AIR BLAST CIRCUIT BREAKER, Allmanna Svenska Elektriska Aktiebolaget, Västeras, Sweden.

According to this invention there is provided in an air blast electric circuit breaker a pressure-sensitive member adapted so that on a predetermined increase in pressure within the extinguishing chamber due to the heat generated by an arc, the member acts upon the means for controlling the flow of compressed air so as to cause reclosing of the contacts. Referring to the upper drawing the circuit breaker comprises a



No. 847,867

compressed-air container *A* to which is attached a pillar insulator *B* carrying a further compressed air container *C* in which are located the operating member *D* carrying the moving contact and insulator *E* with the fixed contact. The movable contact is operated by compressed air supplied through a pipe line *F*, connected with a valve *G*. The valve is operated by two magnetic coils *H* and *K*, which are supplied with current through contacts *L*, *M*, respectively. Contacts *L* and *M*, in their turn, are operated by a pressure-sensitive member *N* attached to the compressed-air container. The pressure-sensitive member is shown in the lower drawing and operates as follows. If a persisting arc between the main contacts in the compressed air container causes the pressure in the

containers to exceed a certain value, due to the temperature rise, then the piston *P* moves to the right. The rod *Q* then pushes the catch *R* sideways so that the rod *S* is released and moved downwards by the spring. The contact bridges *U* and *V* attached to the rod close the closing contacts *L* and open the opening contacts *M*. The contact rod *S* is normally arranged in such a way that it can only be put back into its original position manually.—September 14, 1960.

847,665. June 3, 1957.—ELECTRIC MOTOR CONTROL, Harnischfeger Corporation, 4400 West National Avenue, City of Milwaukee, County of Milwaukee, State of Wisconsin, United States of America.

This invention consists of an apparatus for controlling the speed and direction of rotation of a reversible alternating current electric motor. A variable speed control impedance is associated with the motor, and an electron valve has an output circuit arranged to vary the energisation of the impedance, under the control of a discriminator circuit. Input to the disciminator circuit is derived from a feedback circuit responsive to electric voltage conditions in an electric circuit of the motor, and the discriminator circuit effects a different mode of control depending on whether or not the feedback voltage is above or below the value of a predetermined feedback voltage generated at a pre-selected percentage of slip, (such as 100 per cent slip). The control element of the valve is thereby actuated to cause normal speed regulation variations in the output current of the valve for feedback voltages below the predetermined value, and to cause an abnormal variation in the output current of the valve for feedback voltages above this value, for protective purposes. Protection of the motor may be effected by varying an impedance in circuit with the motor windings, or alternatively by varying the energisation of a winding in an electro-magnetic brake coupled to the motor.—*September* 14, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Oct. 21.—LIVERPOOL AND DISTRICT BRANCH: Lecture Theatre, Chadwick Physics Laboratory, The University, Liverpool, Ramsey Regional Lecture, "Nuclear Power and Propulsion," R. V. Moore, 7.30 p.m. ★ STOKE AND CREWE BRANCH: Grand Hotel Hanley, "Silicones and their Applications in the Electrical Industry," J. H. Davis, 7.30 p.m.

Tues., Oct. 25.—PORTSMOUTH AND DISTRICT BRANCH: H.M.S. "Collingwood," Fareham, "Safety in the Utilisation of Electricity," S. J. Emerson, 7.30 p.m.

Thurs., Oct. 27.—SOUTH LONDON BRANCH: Grayhound Hotel, High Street, Croydon, Surrey, "Industrial Applications of Isotopes," T. B. Rowly, 8 p.m. ★ OXFORD AND DISTRICTS BRANCH: Reactor School, A.E.R.E., Harwell, "Interference Suppression in Industrial and Research Establishments," A. C. F. Leadbitter, 5.45 p.m. ★ SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, Joint meeting with the Electrical Contractors' Association, 7.30 p.m.

Fri., Oct. 28.—COVENTRY AND DISTRICT BRANCH: E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, "Technical Education for the Electrical Engineer" M. M. Robins, 8 p.m.

Sat., Oct. 29.—SOUTH LONDON BRANCH: Visit to National Physical Laboratory, Teddington, 10 a.m.

BRITISH COLOUR COUNCIL

Thurs., Oct. 27.—Shelbourne Hotel, Dublin, One-day conference on "Colour," to be held in association with the Federation of Irish Industries.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Oct. 26.—WEST MIDLANDS SECTION: Department of Electrical Engineering, University of Birmingham, Edgbaston, Birmingham, "Industrial Applications of Automatic Control using Electronic Techniques," R. J. F. Howard, 7.15 p.m. ★ SOUTH WESTERN SECTION: School of Management Studies, Unity Street, Bristol, "Radio Aids for Automatic Landing Developed by the Blind Landing Experimental Unit," J. S. Shayler, 7 p.m. ★ SOUTHERN SECTION: Lanchester Building, The University, Southampton, "Some Aspects of Component Usage," J. S. Brooks, 7 p.m.

Wed. and Thurs., Oct. 26 *and* 27.—LONDON SECTION: School of Pharmacy, Brunswick Square, London, W.C.1, Two-day Symposium on "New Components," Wed., 10.45 a.m., Thurs. 10 a.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., Oct. 26.—MIDLAND REGION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Scheduled Maintenance of Boiler Plant and Auxiliaries," 10.30 a.m.

ENGINEERS' GUILD

To-day, Oct. 21.—KENT BRANCH: Bell Hotel, Bromley, Kent, Inaugural Meeting, 6.30 p.m.

Wed., Oct. 26.—WESTERN BRANCH: Assize Court Hotel, Bristol Annual General Meeting, 6 p.m.

Mon., Oct. 31.—ESSEX BRANCH: Dr. Johnson Hotel, Longwood Gardens, Barkingside, Inaugural Meeting, 8 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Oct. 24.—BIRMINGHAM CENTRE: Visit to Worcestershire Police Headquarters and Museum, C.I.D., Hindlip Hall, Worcester, 7.30 p.m.

Wed., Oct. 26.—LEICESTER CENTRE: A.E.I. Lamp and Lighting Company, Ltd., Melton Road, Leicester, "Light Sources and their Applications," H. R. Ruff, 5.45 p.m.

Mon., Oct. 31.—LEEDS CENTRE: Institute of Technology, Bradford, "Ship Lighting—Perils and Prospects for the Lighting Engineer," J. T. Grundy, and C. H. Vaughan, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Oct. 26.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, "Precision in Casting," A. Short, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Wed., Oct. 26.—SCOTTISH SECTION: Weir Hall, The Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Apprenticeship and Ministry of Transport Examination Requirements for Junior Marine Engineers," C. A. Creber, 7.30 p.m. ★ NORTH MIDLANDS SECTION: British Iron and Steel Research Association Building, Hoyle Street, Sheffield, 3, "The Care and Maintenance of High Pressure Watertube Boilers," W. R. Harvey, 7.15 p.m.

Thurs., Oct. 27.—WEST MIDLANDS SECTION: Engineering Centre, Stephenson Place, Birmingham, "Recent Developments in Pump Auxiliaries for Ships," T. McAlpine, and I. S. Paterson, 7 p.m.

INSTITUTE OF METALS

Wed., Oct. 26.—MANCHESTER METALLURGICAL SOCIETY: Manchester Literary and Philosophical Society, George Street, Manchester, "Metallurgical Aspects in the Development of Fast Fission Reactors," C. R. Tottle, 6.30 p.m.

Thurs., Oct. 27.—BIRMINGHAM LOCAL SECTION: College of Technology, Gosta Green, Birmingham, Presidential Address, L. G. Beresford, 6.30 p.m. ★ SOUTHAMPTON METALLURGICAL SOCIETY: The University, Southampton, "Direct Observations of Dislocations," R. B. Nicholson, 7.15 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Oct. 26.—NORTHERN CENTRE: Commercial Hotel, Accrington, "Taking Stock on Maintenance," P. H. Wyke Smith, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 25.—N.W. BRANCH: Chemical Engineering Lecture Theatre, Manchester College of Science and Technology, Jackson Street, Manchester, "Computers and their Application in Chemical Engineering," D. W. Holman and J. J. Settle, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 25.—Great George Street, Westminster, London, S.W.1, "The Application of Work Study to Local Authority Problems," M. E. Habershon, 5.30 p.m.

Thurs., Oct. 27.—TRAFFIC ENGINEERING STUDY GROUP: Great George Street, Westminster, London, S.W.1, Informal Discussion on "Dartford Tunnel Origin and Destination Survey," introduced by F. A. Rayfield, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Oct. 21.—SOUTHERN CENTRE: S.E.B. Showrooms, Newport, Isle of Wight, "The Application of Irradiation in Industry," M. C. Crowley-Milling, 6.30 p.m.

Mon., Oct. 24.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, Chairman's Address, "Southern Region, Kent Coast Electrification Scheme—Power Supply Apparatus," A. Porter, 6.30 p.m. ★ EAST ANGLIAN SUB-CENTRE: Electric House, Ipswich, "Electrical Installation Practice," E. J. Sutton, 6.30 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "Safety in the Utilisation of Electricity," S. J. Emerson, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE: Angel Hotel, Brigg, "Electrical Contracting in Commerce and Industry," E. J. Lilleker, 7 p.m. ★ NORTH-WESTERN CENTRE, EDUCATION DISCUSSION CIRCLE: Technical College, Bolton, Discussion on "Selection of Students for Appropriate Courses," opened by G. W. Carter, and A. J. Jenkinson, 6.15 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, "Automatic Control of Machines for Assembling Bicycle Parts," A. V. Hemingway and R. L. Dressler, 6 p.m. ★ WESTERN UTILISATION GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, Chairman's Address, "Developments in Electrical Plant for Industry," J. M. Ferguson, 6 p.m.

Tues., Oct. 25.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "Rapid Methods for Ascertaining Whether the Activity of a Weak Radioactive Sample Exceeds a Predetermined Level," E. H. Cooke-Yarborough and R. C. M. Barnes, 5.30 p.m. ★ NORTH-EASTERN CENTRE: Technical College, Carlisle, "Safety in the Utilisation of Electricity," S. J. Emerson, 7 p.m. ★ NORTH-WESTERN SUPPLY GROUP: Engineers' Club, Manchester, "Field Suppression of Turbo-Alternators," J. R. Hill, A. Hunt, W. J. Joyce and D. H. Tompsett, 6.15 p.m.

Wed., Oct. 26.—ELECTRONICS AND COMMUNICATIONS SECTION: Savoy Place, London, W.C.2, Chairman's Address, "Channelling—A Sketch," T. B. D. Terroni, 5.30 p.m. LONDON GRADUATE AND STUDENT SECTION: Visit to G.P.O. Mount Pleasant, London, E.C.1, 2.30 p.m. ★ NORTH-WESTERN CENTRE: Lostock Alkali Social Club, Lostock Gralam, Near Knutsford, "Electricity in the Manufacture of Hydrogen Peroxide," B. E. A. Vigers, and R. O. Fletcher, 6.30 p.m. ★ SOUTH MIDLAND CENTRE, EDUCATION DISCUSSION CIRCLE: College of Advanced Technology, Birmingham, Discussion on "The Non-Destructive Testing of Materials," opened by J. C. Wright, 6 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, "Water-Turbine-Driven Induction Generators," C. L. C. Allan, 6.30 p.m.

Thurs., Oct. 27.—ORDINARY MEETING: Savoy Place, London, W.C.2, "The Principles and Operation of Large Radio Telescopes," A. Hewish, 5.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Department, Queen's College, Dundee, Sub-Centre Chairman's Address, L. F. Dorward, 7 p.m. ★ SOUTH MIDLAND CENTRE: Midland Institute, Paradise Street, Birmingham, Joint meeting with the Institutions of Civil and of Mechanical Engineers, "Some Aspects of Engineering in Polar Regions," D. L. Pratt, 6.30 p.m.

Fri., Oct. 28.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, Sub-Centre Chairman's Address, L. F. Dorward, 7.30 p.m.

Mon., Oct. 31.—EAST ANGLIAN SUB-CENTRE: Assembly House, Norwich, "Modern Coal-Fired Power Stations," A. E. Hawkins, 7.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, "The Application of Irradiation in Industry," M. C. Crowley-Milling, 6.30 p.m. ★ NORTH-EASTERN MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne, "New Amplifying Techniques," C. W. Oatley, 6.15 p.m. ★ SOUTH MIDLAND CENTRE: Winter Gardens, Great Malvern, Malvern and District Group Annual General Meeting; and "Application of Microwaves," A. L. Cullen, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 21.—EDUCATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion, "Is It Possible to Teach Design?" 6 p.m.

Tues., Oct. 25.—SOUTHERN BRANCH: Small Town Hall, Reading, "Mechanical Engineering Education in Technical Colleges," A. Till, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION: Anglesea Road Annexe of College of Technology, Portsmouth, "Design and Application of Mechanisms in the Computer Field," Mr. Groom, 6.30 p.m.

Wed., Oct. 26.—ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, "The Scientist's Contribution to Mechanical Engineering," Owen A. Saunders, 6 p.m. ★ E. MIDLANDS GRADUATES' SECTION: College of Further Education, Loughborough, "The Control Scheme of Diesel-electric Locomotives 05500-05519," L. S. Thorpe, 7.15 p.m.

Thurs., Oct. 27.—MIDLAND BRANCH: Midland Institute, Paradise Street, Birmingham, Joint meeting with Institutions of Civil and Electrical Engineers, "Some Aspects of Engineering in Polar Regions," D. L. Pratt, 6.30 p.m. ★ SOUTHERN BRANCH: College of Technology, Boundary Road, Farnborough, Hants, "A Propulsion System for British Earth Satellites," E. G. D. Andrews, 7.30 p.m. ★ YORKSHIRE BRANCH: Royal Station Hotel, York, "Future Developments in Corrosion Prevention," T. Henry Turner, 7.30 p.m. ★ WESTERN A.D. CENTRE: Royal Hotel, Bristol, A.D. Chairman's Address, 6.45 p.m. ★ LONDON GRADUATES' SECTION: Visit to film theatre of Babcock and Wilcox, Ltd., at Babcock House, 6.30 p.m.

Fri., Oct. 28.—WESTERN BRANCH: Technical College, Swindon, "Modern Aids in the Design of Railway Bogies," A. W. Manser, 7.30 p.m.

INSTITUTION OF PLANT ENGINEERS

Tues., Oct. 25.—SOUTH WALES BRANCH: South Wales Engineers' Institute, Park Place, Cardiff, "The Thermal Insulation of Factory Buildings," N. Foster, 7.30 p.m.

Thurs., Oct. 27.—MERSEYSIDE AND NORTH WALES BRANCH: Exchange Hotel, Liverpool, "On-load Water Washing of Economisers and their Heaters," R. Sheen, 7.15 p.m. ★ NORTH EAST BRANCH: Three Tuns Hotel, Durham City, "Inventions, Patents and the Engineer," C. P. MacCarthy, 7 p.m. ★ SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "The Consultant and Personnel Management," T. H. Hawkins, 7.30 p.m.

Fri., Oct. 28.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Industrial Law," T. W. Wright, 7.30 p.m.

Mon., Oct. 31.—WEST AND EAST YORKSHIRE BRANCH: Houldsworth School of Applied Science, The University, Leeds, "The Building of a Modern Factory," P. Wyatt, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed., Oct. 26.—MIDLANDS REGION: New Technical College, London Road, Shrewsbury, "Development of Rubber in Engineering," E. S. Kendall, 7.30 p.m.

Mon., Oct. 31.—MANCHESTER GRADUATE SECTION: Reynolds Hall, Manchester College of Science and Technology, Manchester, "Production Engineer's Route to the Board Room," G. R. Pryor, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., Oct. 27.—11, Upper Belgrave Street, London, S.W.1, "Structural Considerations of a New Animal Feed Mill in Belfast, Northern Ireland," E. V. Finn and K. F. Shadbolt, 6 p.m.

Fri., Oct. 28.—MIDLAND COUNTIES BRANCH: Byng Kendrick Suite, College of Advanced Technology, Gosta Green, Birmingham, Chairman's Address, G. Gottley, 6.30 p.m.

INSTITUTION OF WATER ENGINEERS

To-day, Oct. 21.—Lecture Hall, Leeds City Art Gallery, The Headrow, Leeds, 1, One-day conference on "Surface Water Resources and the Drought of 1959," 10 a.m.

IRON AND STEEL INSTITUTE

Mon. to Thurs., Oct. 24 *to* 27.—Civic Theatre, Scunthorpe, Forty-first meeting of the Iron and Steel Engineers Group.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 21.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Boiler Management in Small Plants," L. Clegg, 7 p.m.

Fri., Oct. 28.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Formed Ends for Chemical Plant and the Like," J. M. Tebby, 7 p.m.

PLASTICS INSTITUTE

Mon., Oct. 24.—City of London College, Moorgate, London, E.C.2, "Plastics as Replacement Materials," K. B. Bartlett, 6.15 p.m.

Mon., Oct. 31.—City of London College, Moorgate, London, E.C.2, "Creation of New Markets by Plastics Materials," C. W. Welch, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Oct. 25.—SCOTTISH BRANCH: North British Hotel, Edinburgh, Films, 6.30 p.m.

Thurs., Oct. 27.—WEST OF ENGLAND BRANCH: New School of Engineering, The University, Bristol, "Practical Formwork Design and Construction," J. G. Richardson, 6 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Tues., Oct. 25.—Institute of Marine Engineers, 76, Mark Lane, London, E.C.3, "Observations on the Design and Construction of the N.S. 'Savannah,'" J. A. Dodds and S. MacDonald, 5.30 p.m.

ROYAL METEOROLOGICAL SOCIETY

Fri., Oct. 28.—SCOTTISH CENTRE: Department of Natural Philosophy, Drummond Street, Edinburgh, "The Influence of the Atmosphere on Sea Level," J. R. Rossiter, 5 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Mon., Oct. 24.—CORROSION GROUP: 14, Belgrave Street, London, S.W.1, Cathodic Protection Panel Meeting, Brains Trust, J. S. Gerrard, J. H. Morgan, K. A. Spencer and W. G. Waite, 6 p.m.

Wed., Oct. 26.—MIDLANDS BRANCH CORROSION GROUP: Large Lecture Theatre, Engineering Centre, Stephenson Place, Birmingham, "Will It Corrode?" U. R. Evans, 7 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Oct. 25.—LONDON SECTION: Manson House, 26, Portland Place, London, W.1, "Instrumentation, Past, Present and Future," L. S. Yoxall, 6.30 p.m.

Wed., Oct. 26.—SOUTH WALES SECTION: Lecture Theatre, Steel Company of Wales, Ltd., Port Talbot, "The Automatic Control of Rolling Mills," W. N. Jenkins, 6.45 p.m.

Thurs., Oct. 27.—CHESTER SECTION: Lecture Theatre, Administration Building, Associated Ethyl Company, Ltd., Oil Sites Road, Ellesmere Port, Wirral, "Analogue Computers," W. E. Willison, 7 p.m.

Fri., Oct. 28.—CHELTENHAM SECTION: Belle Vue Hotel, Cheltenham, "The Atomic Clock," L. Essen, 7.30 p.m. ★ SCOTTISH SECTION: Building Centre, Sauchiehall Street, Glasgow, "Instrumentation of a Steel Strip Mill," H. Gill, 7.15 p.m.

TELEVISION SOCIETY

Thurs., Oct. 27.—Cinematograph Exhibitors' Association Theatre, Third Floor, 164, Shaftesbury Avenue, London, W.C.2, Discussion on "New Standards and the Problem of Colour Television," 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Oct. 21.—39, Elmbank Crescent, Glasgow, "The Physical Metallurgy of Steel," R. W. K. Honeycombe, 6.45 p.m.

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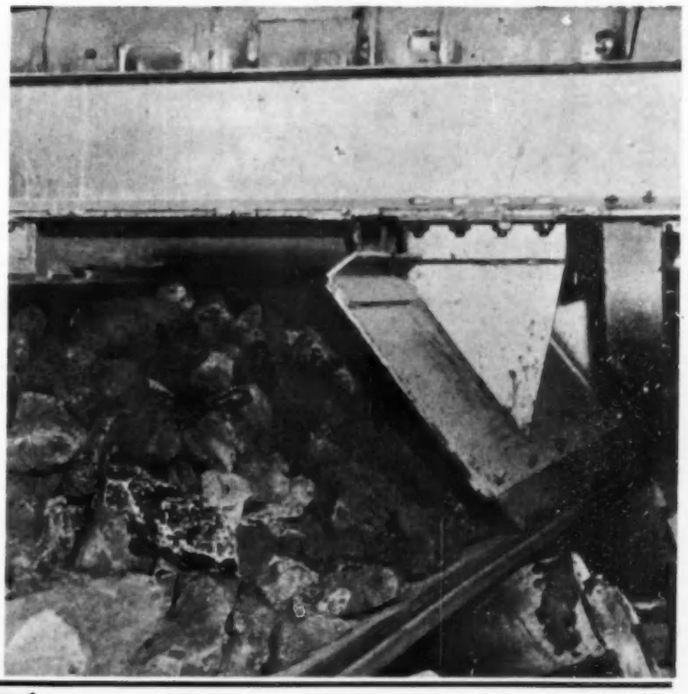

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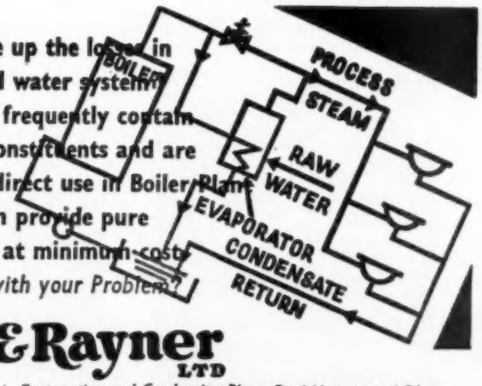

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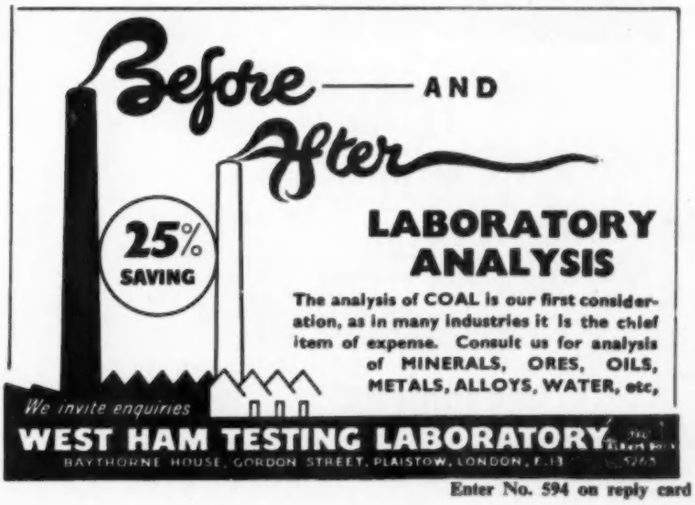
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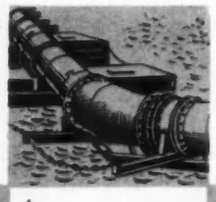

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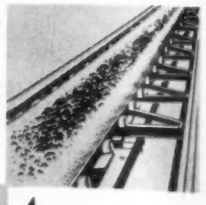
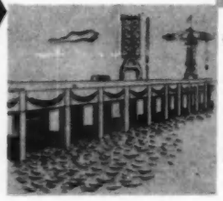


Various types of smooth and profiled belting for coal, iron-ore, etc.



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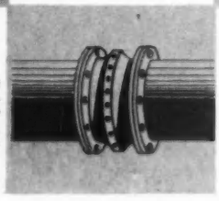

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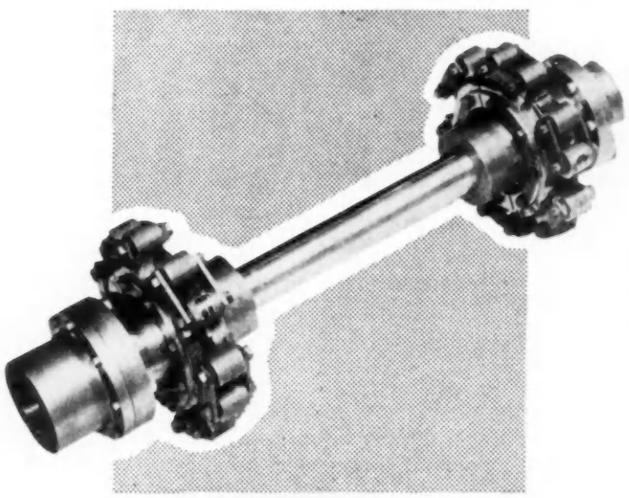

The illustration shows 21" Flexilink Couplings in cardan shaft form — each coupling incorporating self aligning supporting bearings. Twilflex units of this type, transmitting up to 630 h.p. at 500 r.p.m. were used extensively for Ruston diesel engine pumping sets on the vast Trans-Iranian Pipeline project.

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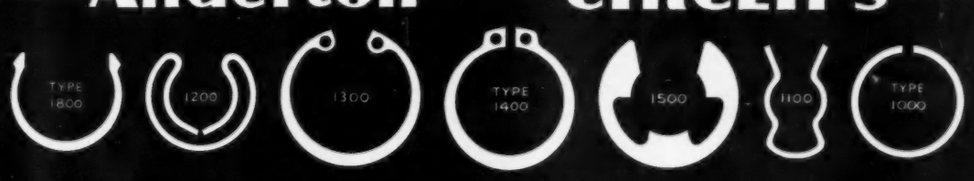

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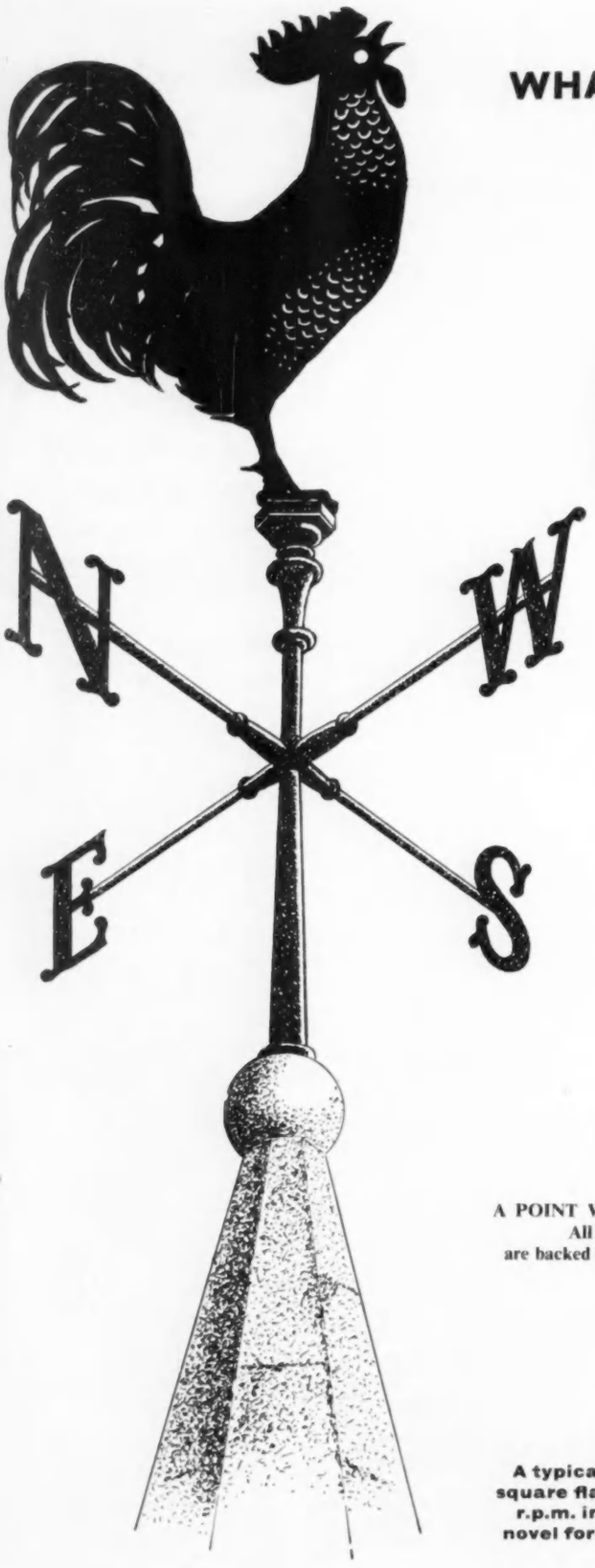

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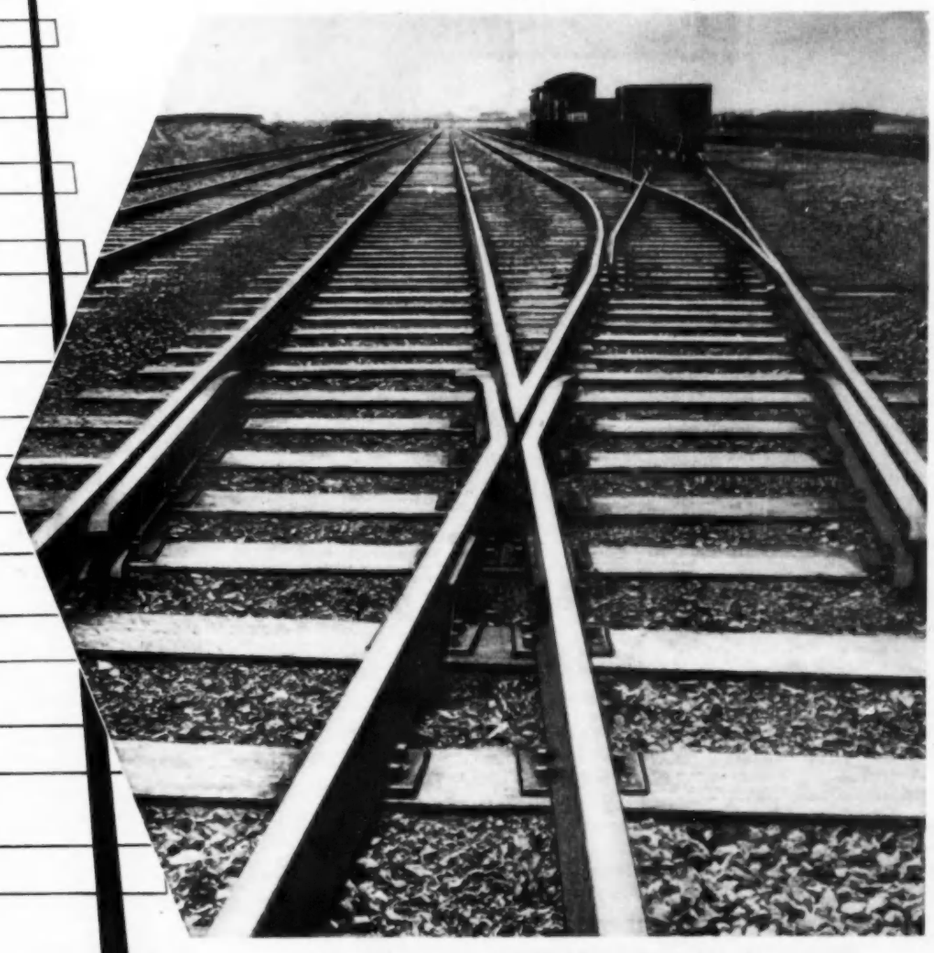

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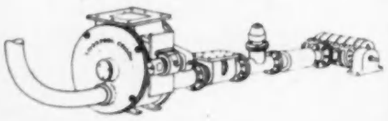

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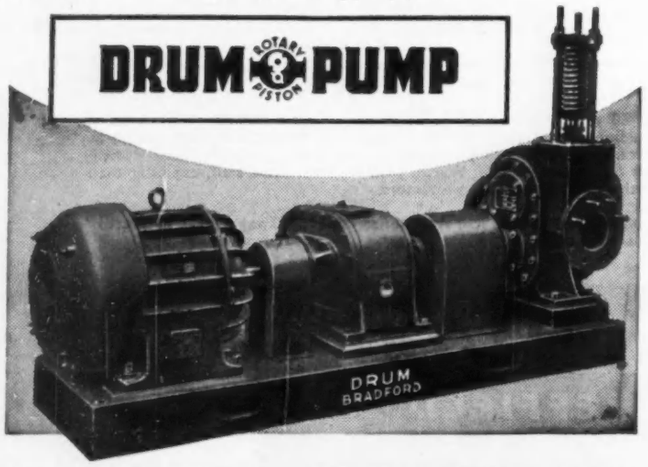

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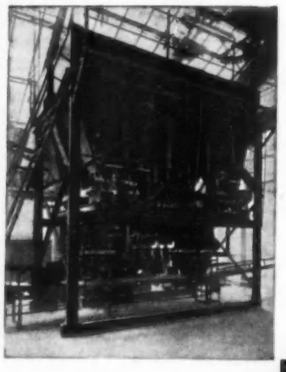

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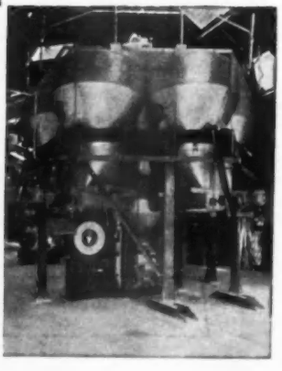

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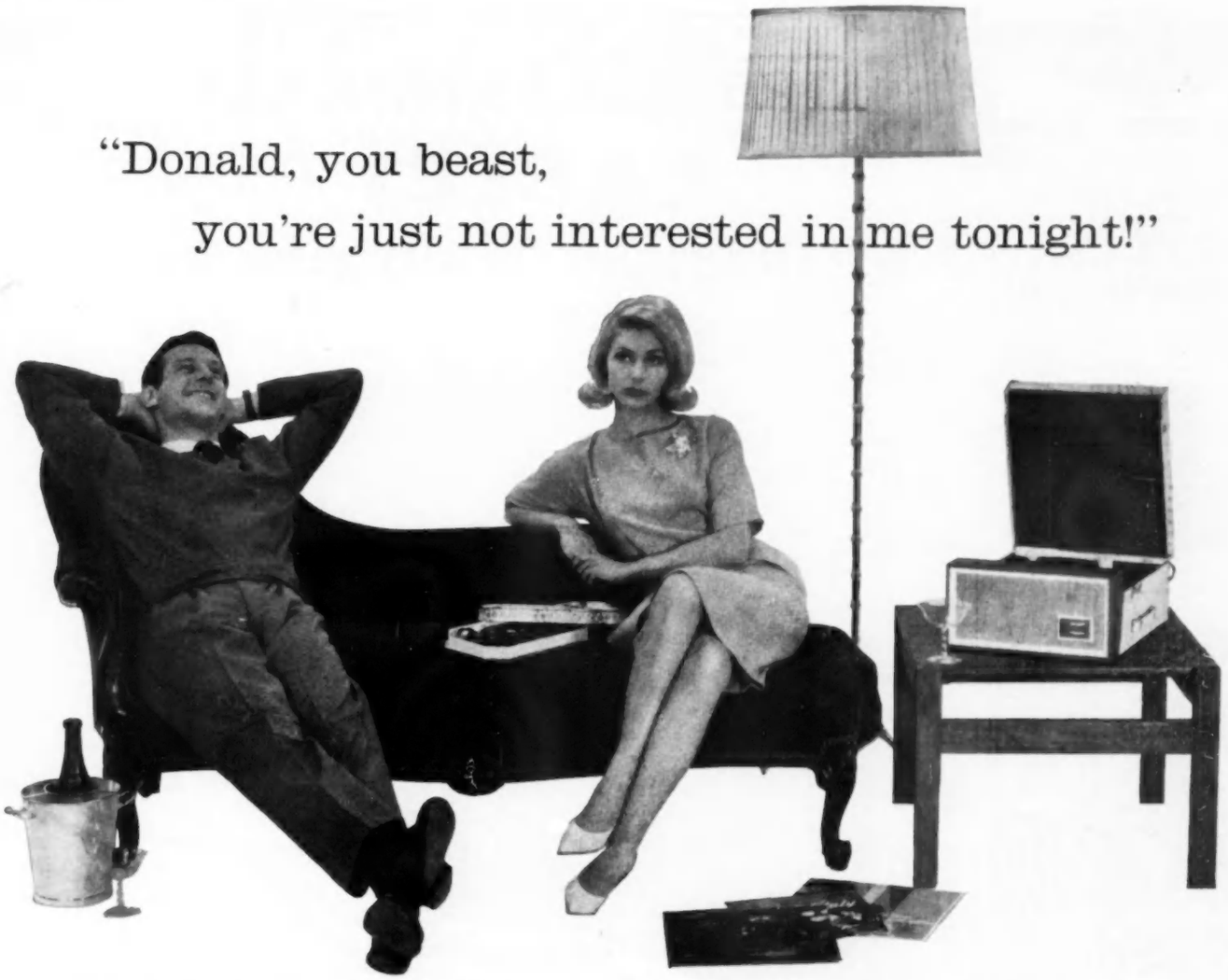

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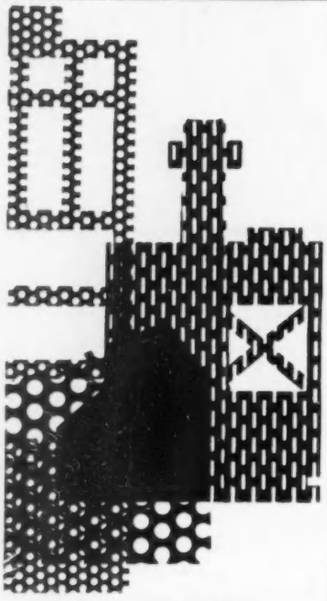

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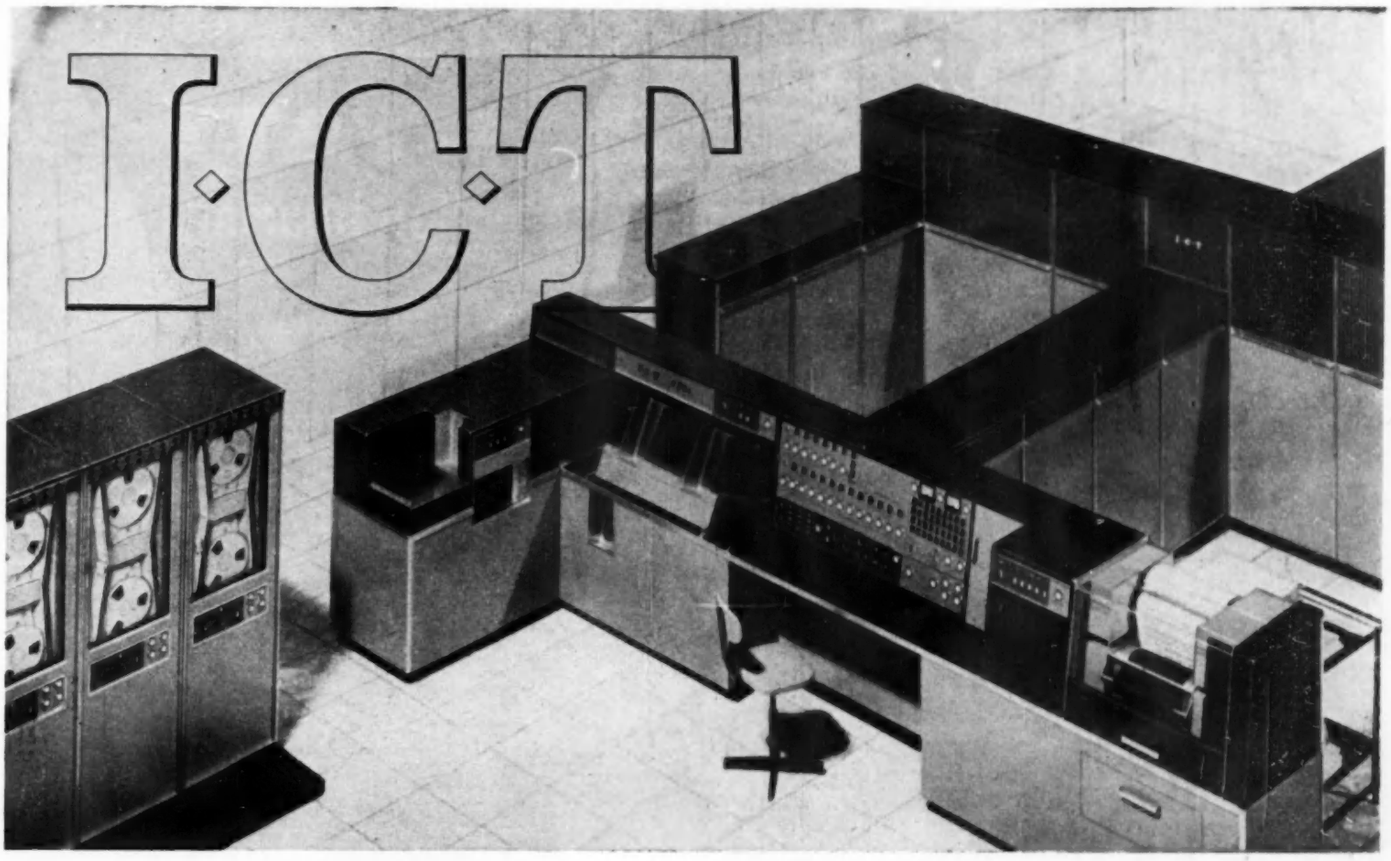

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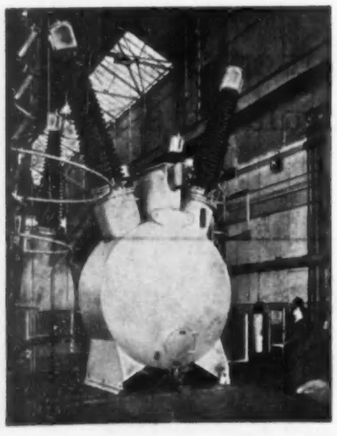

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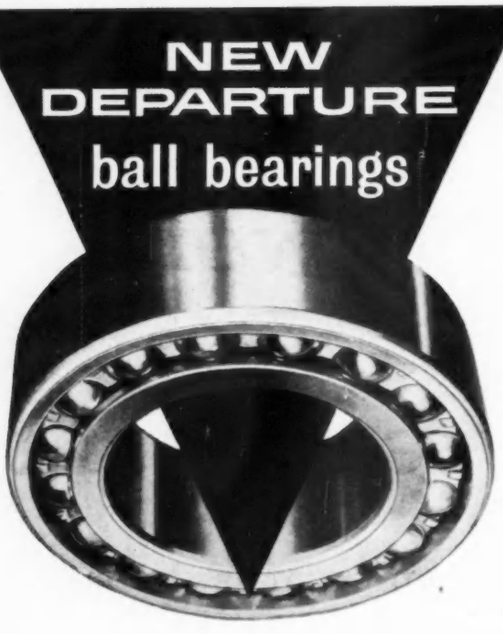

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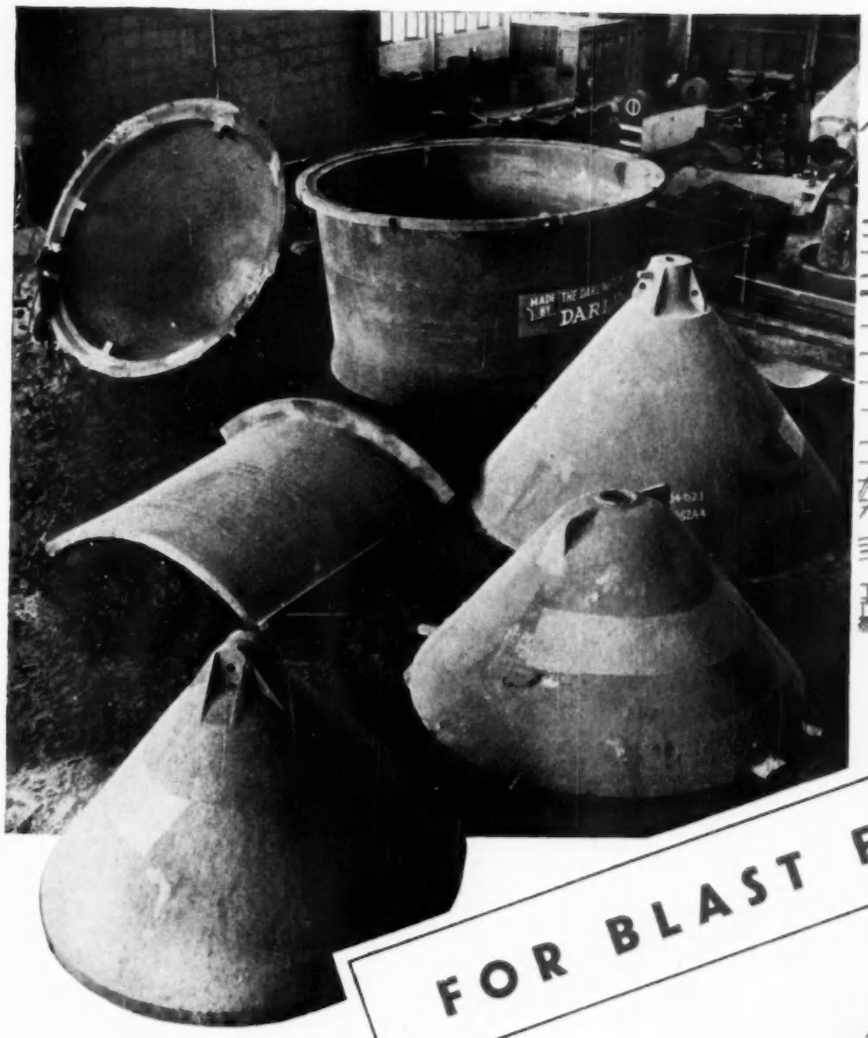

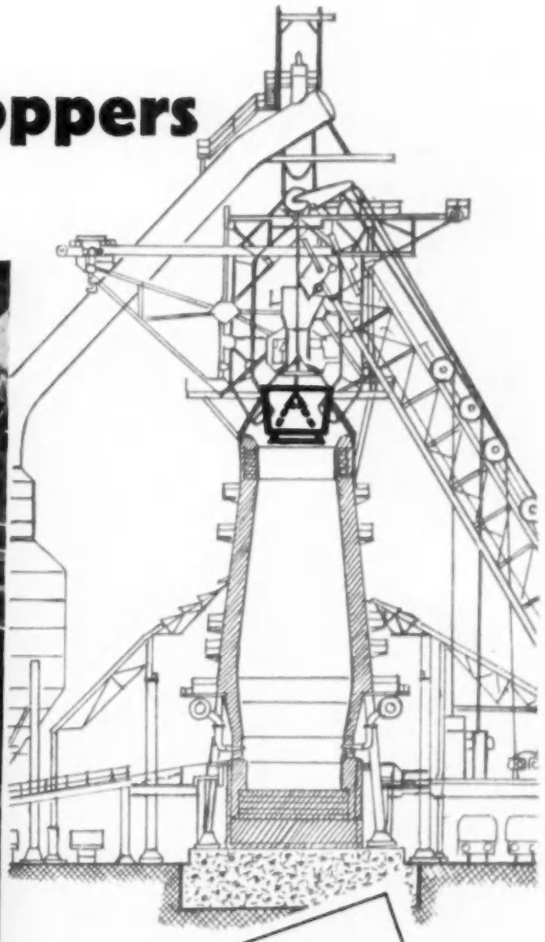

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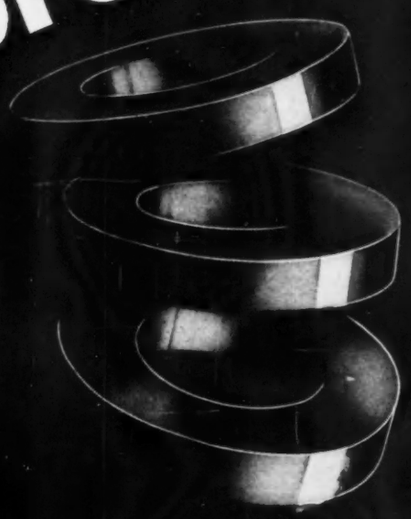

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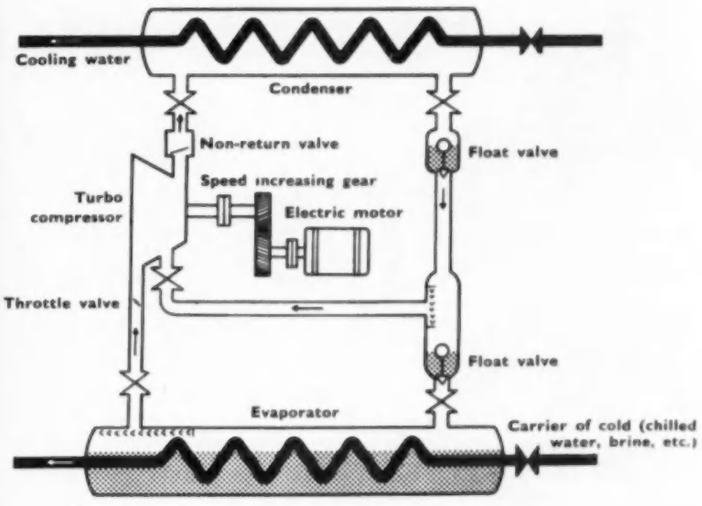

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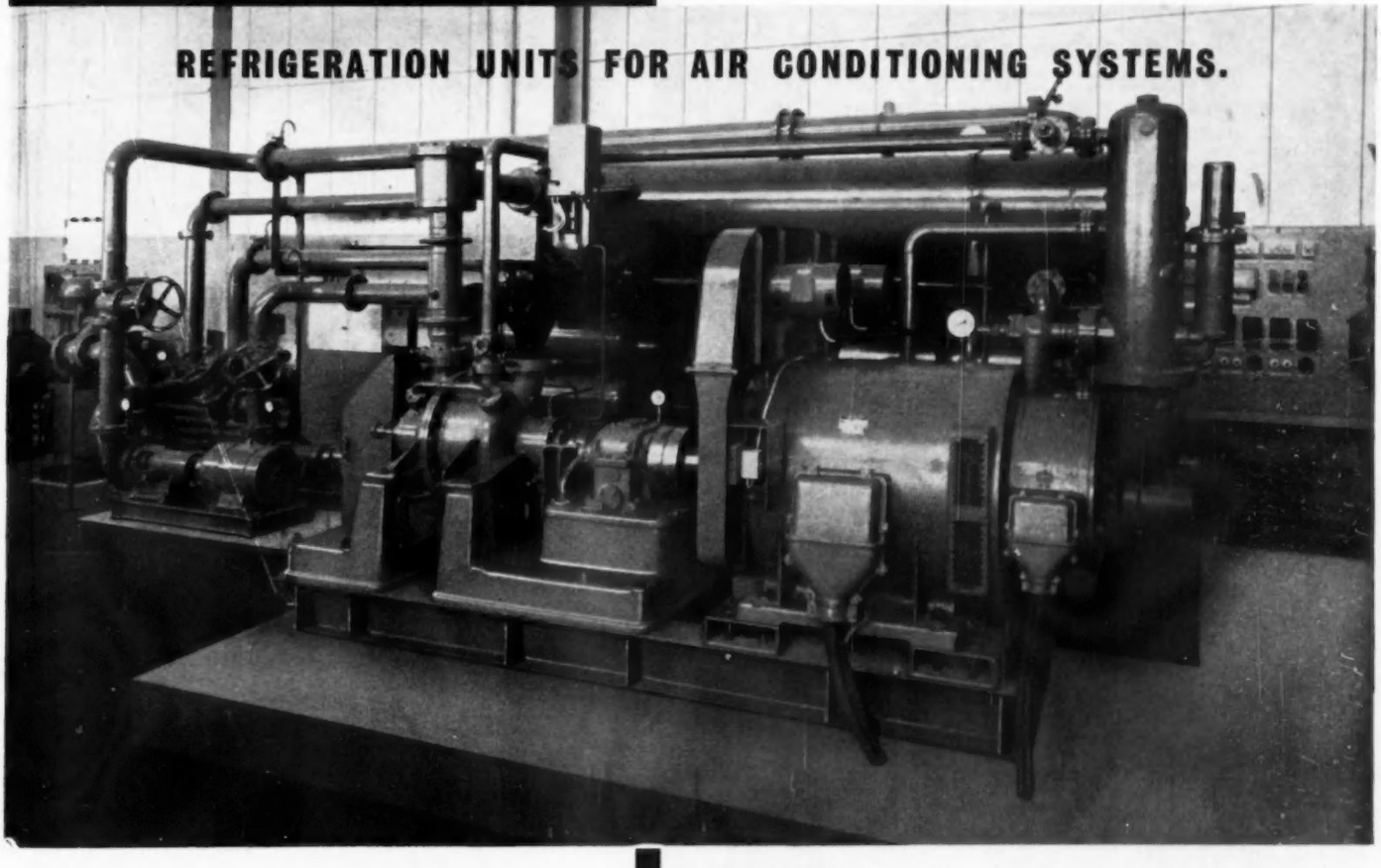

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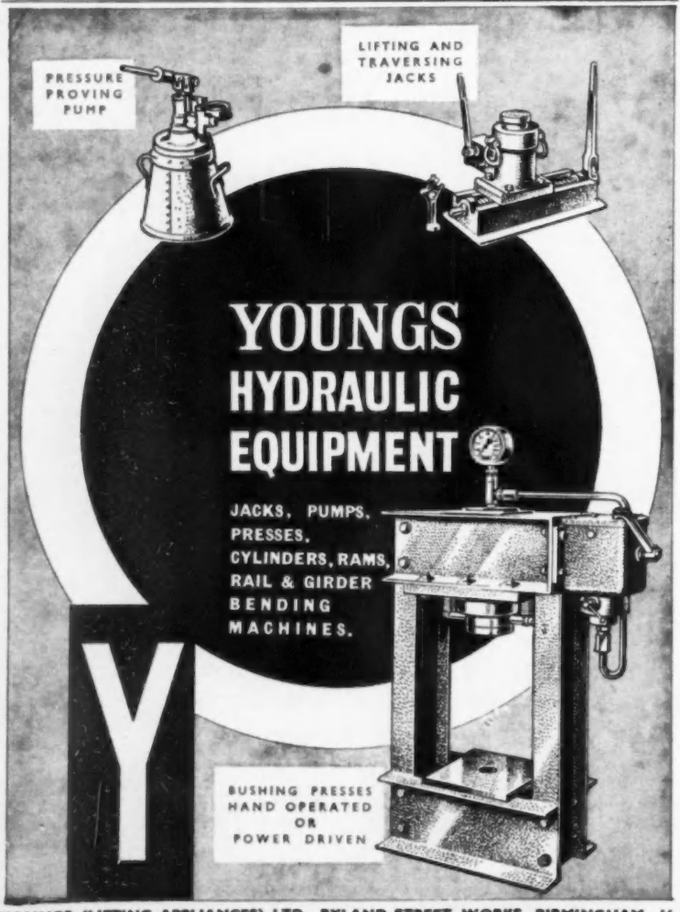
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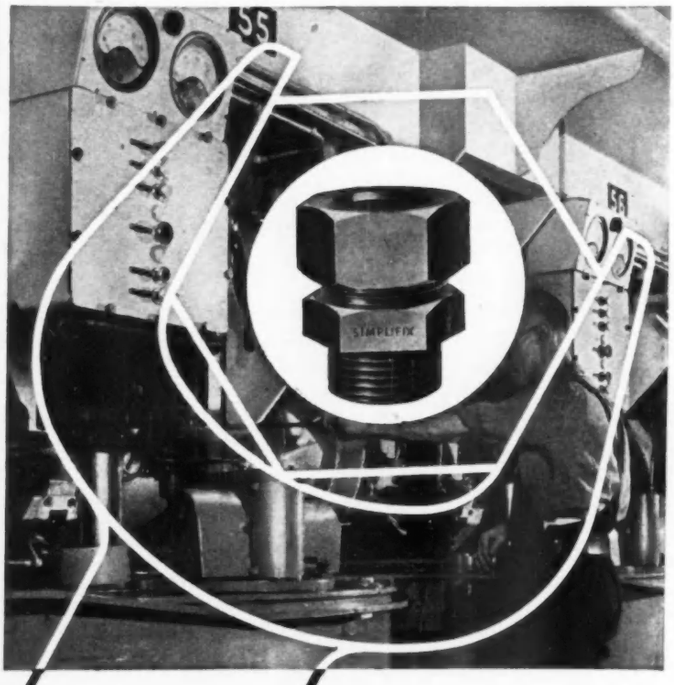

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

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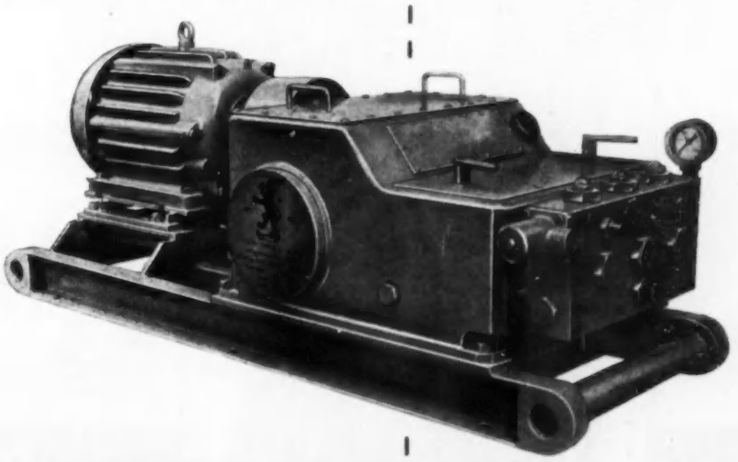

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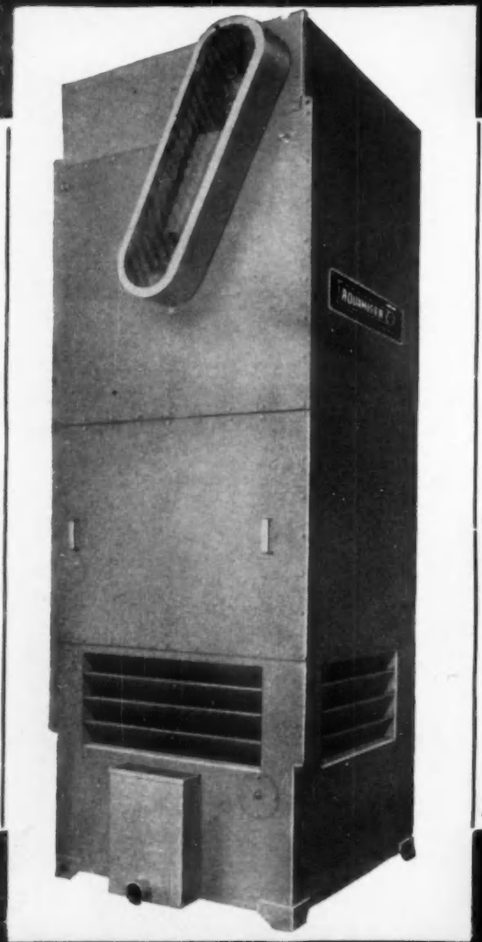
only a ripple on the surface, but ...



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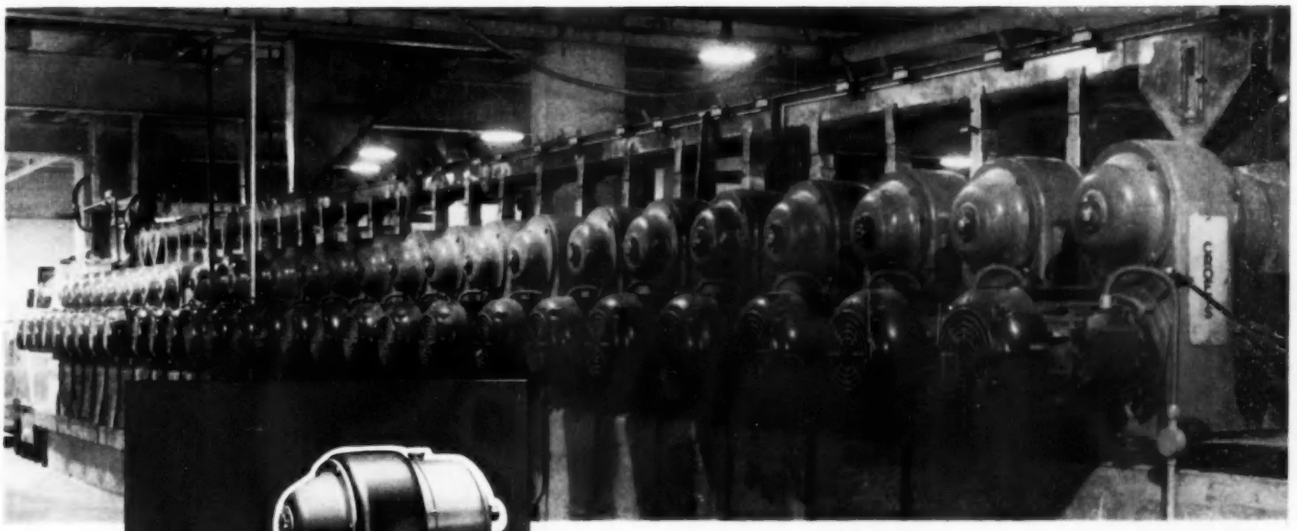

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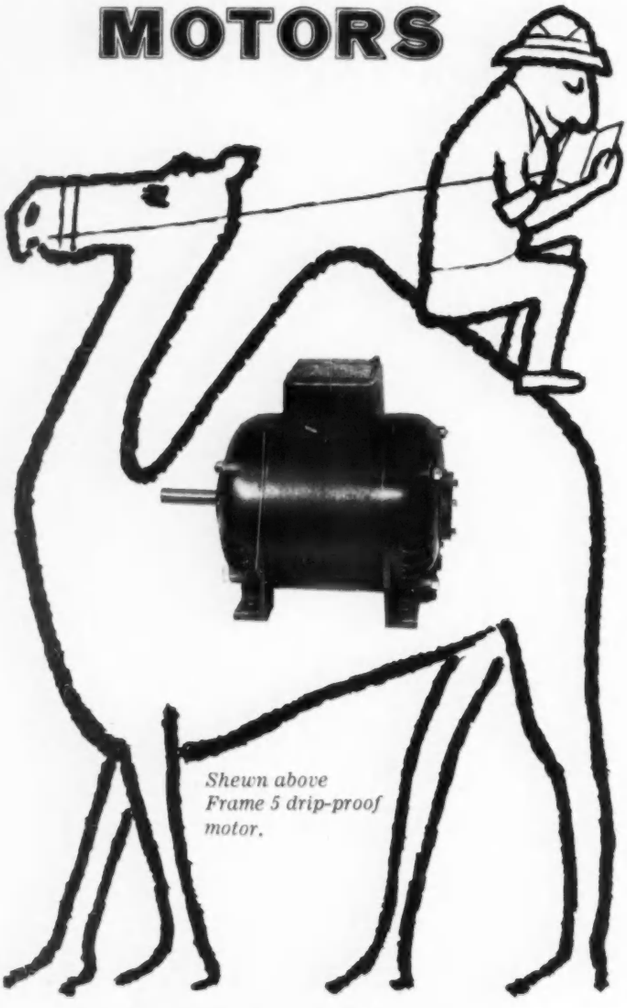

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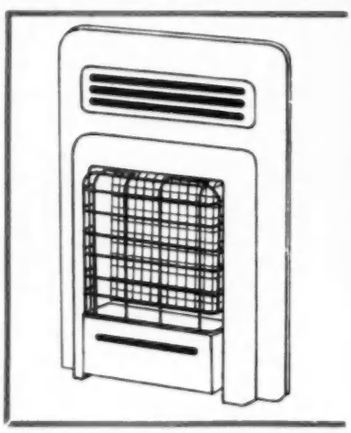

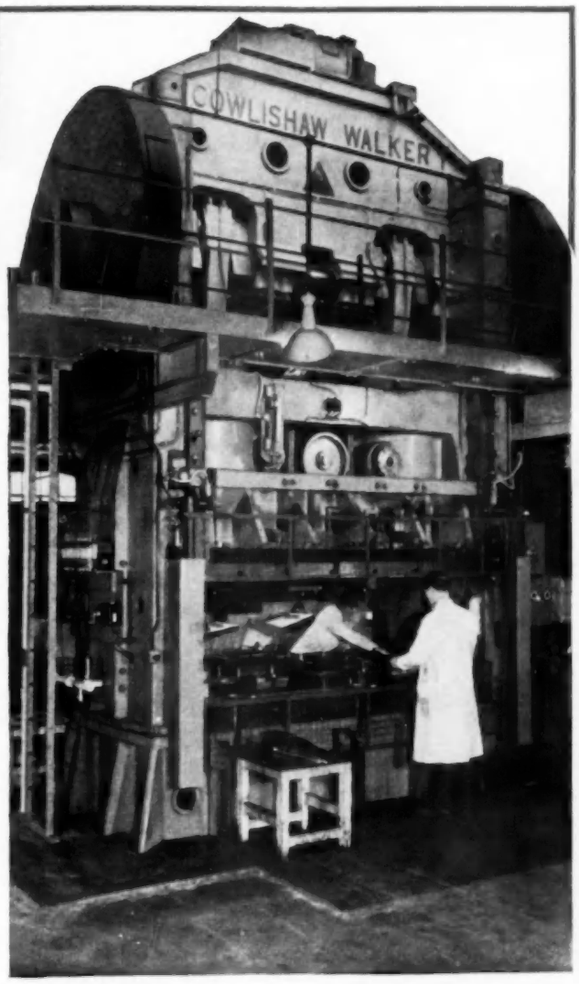

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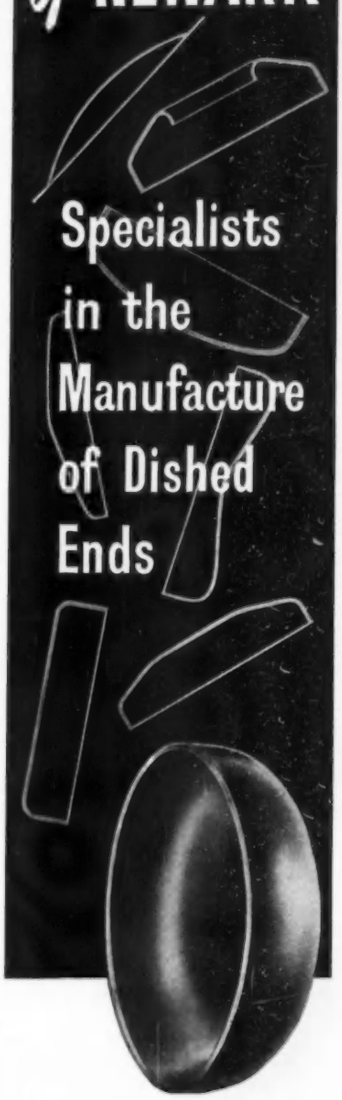

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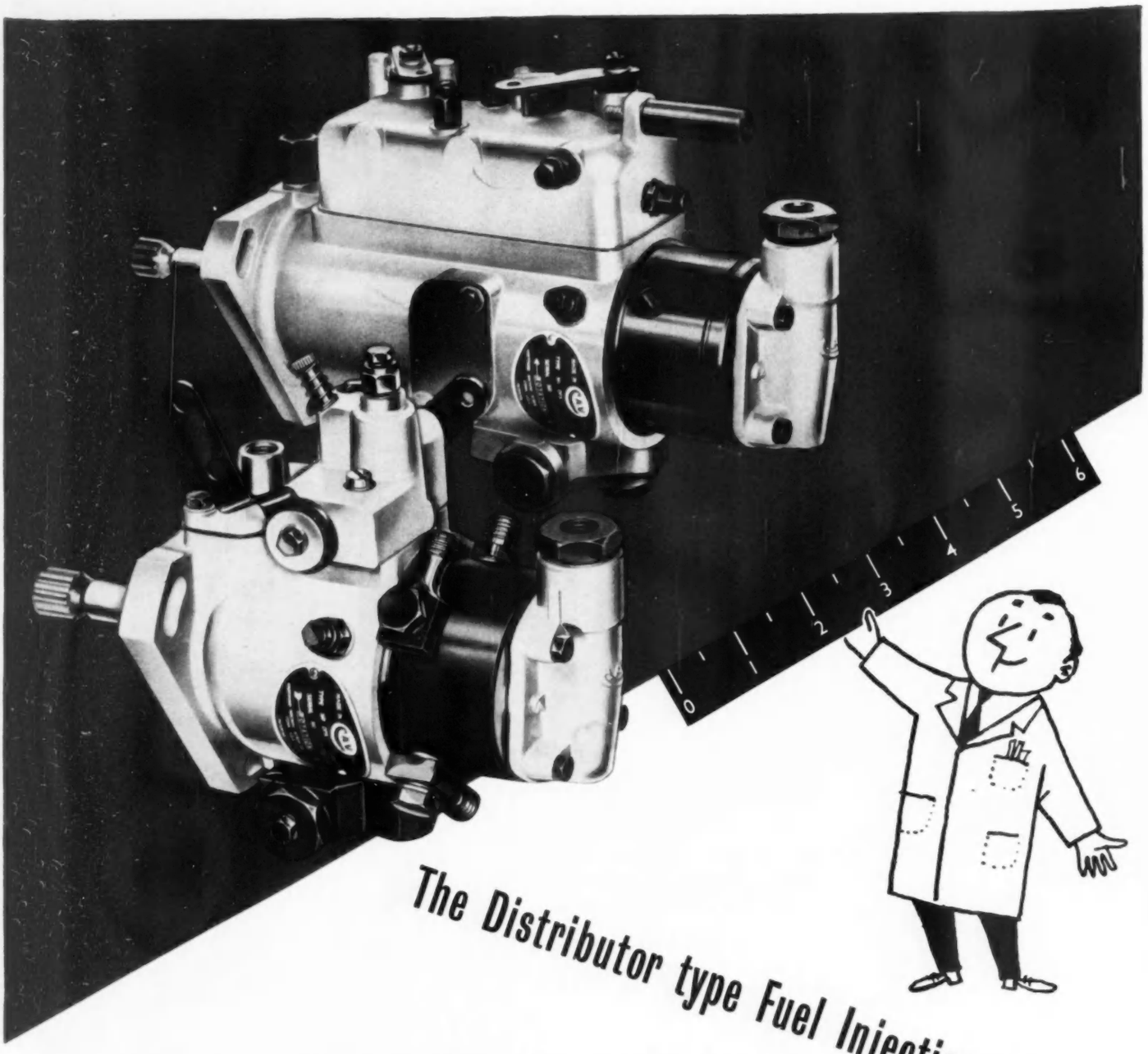

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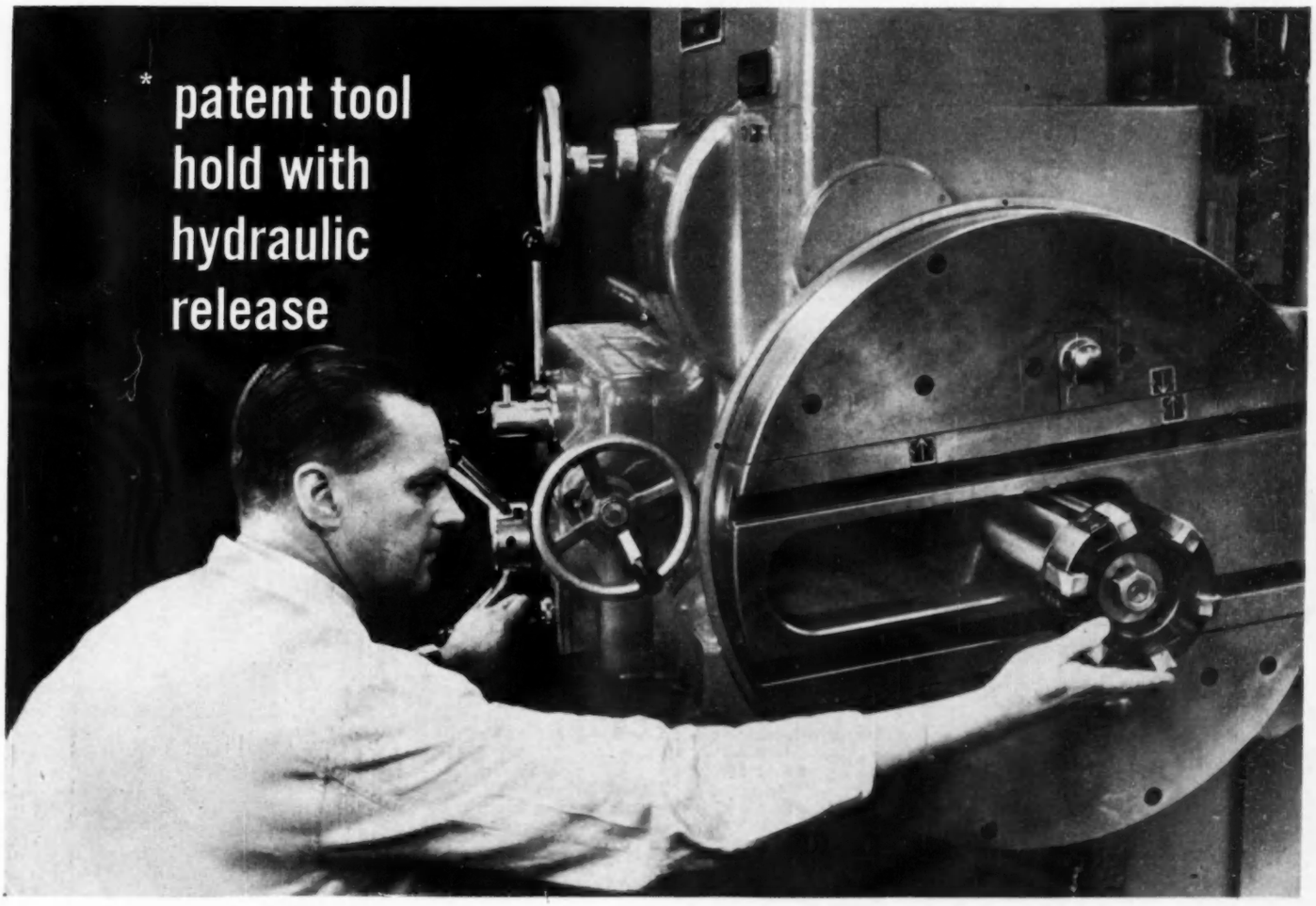

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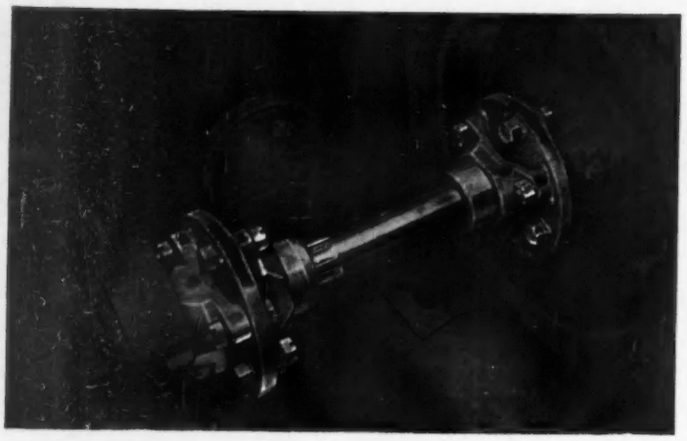

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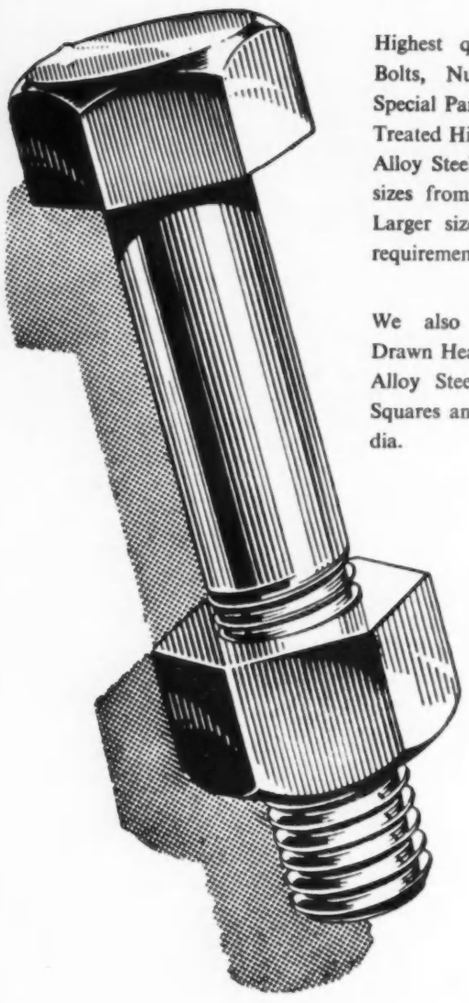

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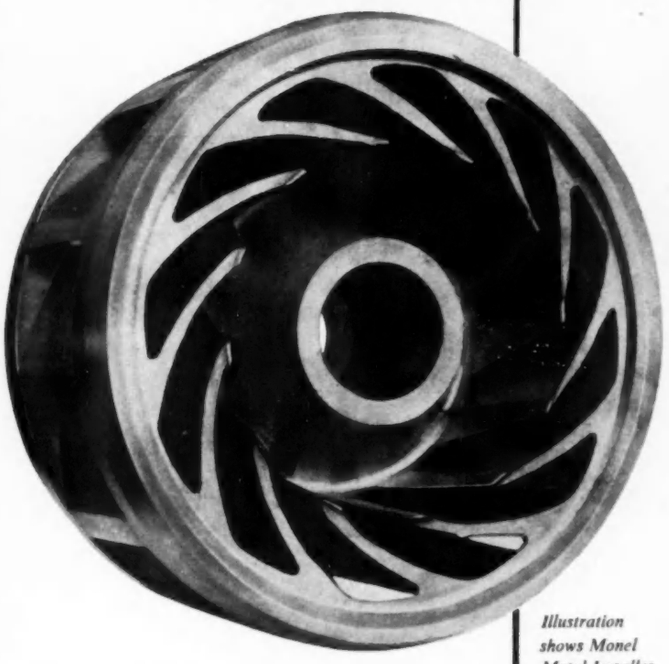

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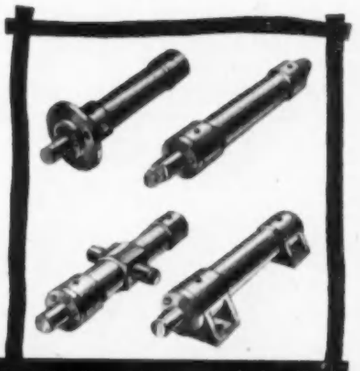

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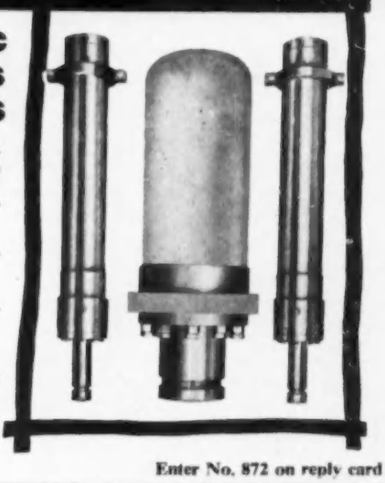

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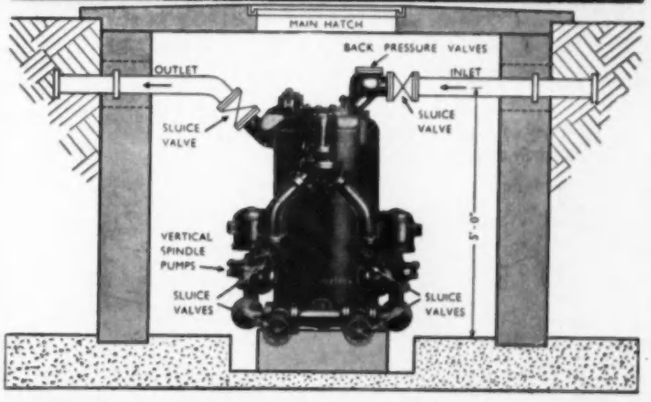
Pulsometer



PATENT SOLIDS DIVERTING PLANT

Double Units capable of continuous inflow of 250 g.p.m.

A closed tank Automatic Sewage Pumping Plant, made in four sizes

Suitable for Small Housing Estates, Factories, Schools, Camps, Etc. Also for pumping trade effluents or other liquids containing solids. Will deal with any solids which can come down a 4-in. domestic drain. The plant leaves the Works complete, ready for coupling up to ingoing and outgoing sewers.

This plant operates on the principle that by temporarily removing the solid matter from the liquid sewage, the actual pumping operation can be performed at high efficiency by a pump of the clean water type, handling liquid sewage only.

Recently developed are the two larger sizes, the patented principle of which makes them very suitable for discharging greater quantities against either low or unusually high heads, beyond the range of normal sewage pumps.

Since 1909 we have supplied automatic Sewage Plants all over the world covering from the smallest to the largest duties. Plants include: **Propeller, Fullway and Freeway, Stereophagus and Disintegrator Pumps**

PULSOMETER ENGINEERING CO. LTD.
NINE ELMS IRONWORKS, READING

Telephone: Reading 67182/5 London Office: Pulsometer House, 20/26, Lamb's Conduit Street, W.C.1.
Also Birmingham, Cardiff, Glasgow, Leeds, Manchester, Newcastle upon Tyne.

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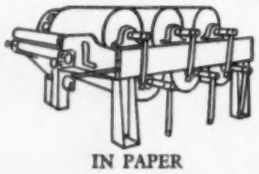
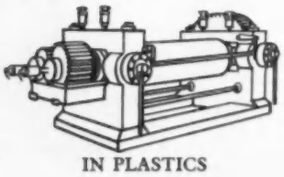
ROLL CLADDING for permanent protection

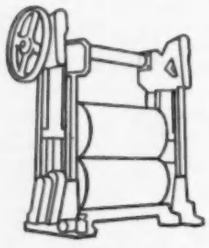
The many advantages of the roll cladding have made it immediately acceptable in many industries:



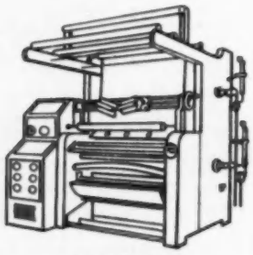
IN PAPER



IN PLASTICS



IN TEXTILES



IN DYEING

London Office: 12 Portland Place, W.1. Tel.: LANgham 5588.

in Stainless Steel, for Rolls, Shafts, Tubes & Drums

Many corrosion problems in industry can now be overcome more efficiently and cheaply using Rosedowns roll cladding process in which a thin shell of corrosion-resistant material is applied to the external diameters of cylindrical bodies.
Rosedowns supply complete clad rolls or alternatively, the process can be applied to customers' own rolls, shafts etc. Work is accepted from 4 to 42 inches in diameter, in length up to 23 feet 6 inches, machined, ground and polished to precision limits.

ROSEDOWNS

ROSE, DOWNS & THOMPSON LTD.

Old Foundry, Hull, England. Tel: 29864

DAVY-ASHMORE GROUP

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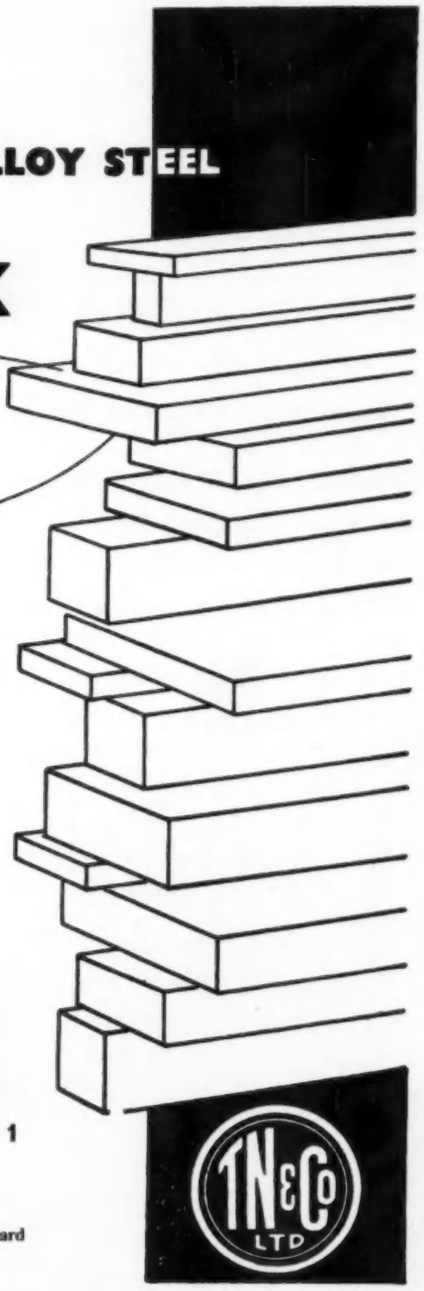
CARBON CHROME ALLOY STEEL
GROUND FLAT STOCK

Guaranteed to ± 0·001 in thickness



Indispensable in the manufacture of jigs, templates, gauges, press tools, etc., oil hardening, non-distorting steel in standard 18in. lengths. Each piece separately packed with full heat treatment instructions. Standard 18in. lengths also non-standard sizes 12in., 24in. and 36in. lengths. Widths from 3/16in., to 12in., thicknesses from 1/32in. to 2in.
We hold large stocks of non-standard sizes and Round Stock ¼in. to 2¾in. dia.

30,000 LENGTHS ALWAYS IN STOCK

Write for specifications and prices

MAIN STOCKHOLDERS & DISTRIBUTORS

T. NORTON & CO. LTD

CARVER STREET BIRMINGHAM 1

Telephone: Central 4325 (5 lines)

TN&Co LTD

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MILLERS RINGS LTD

★ QUICK SERVICE
★ ANY TYPE SECTION
★ TRUE DIAMETER GUARANTEED

HENEAGE STREET, LONDON E.1
BISHOPSGATE 7314

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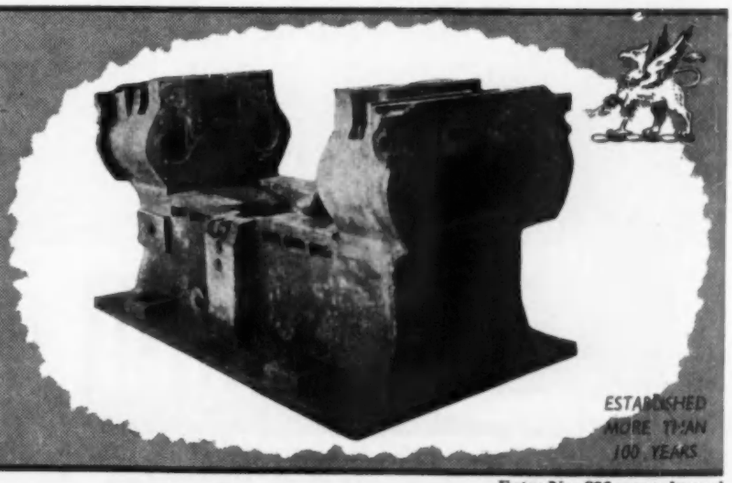
IRON CASTINGS

For Engineering and all Kindred Trades

ANY SIZE - ANY SHAPE

Also Patterns and Machining



ESTABLISHED MORE THAN 100 YEARS

HB **HUNT BROS (OLDBURY) LTD**
GRIFFIN FOUNDRY, OLDBURY
Near BIRMINGHAM
Telephone: BROADWELL 1101 & 1102 Telegrams: GRIFFIN, OLDBURY

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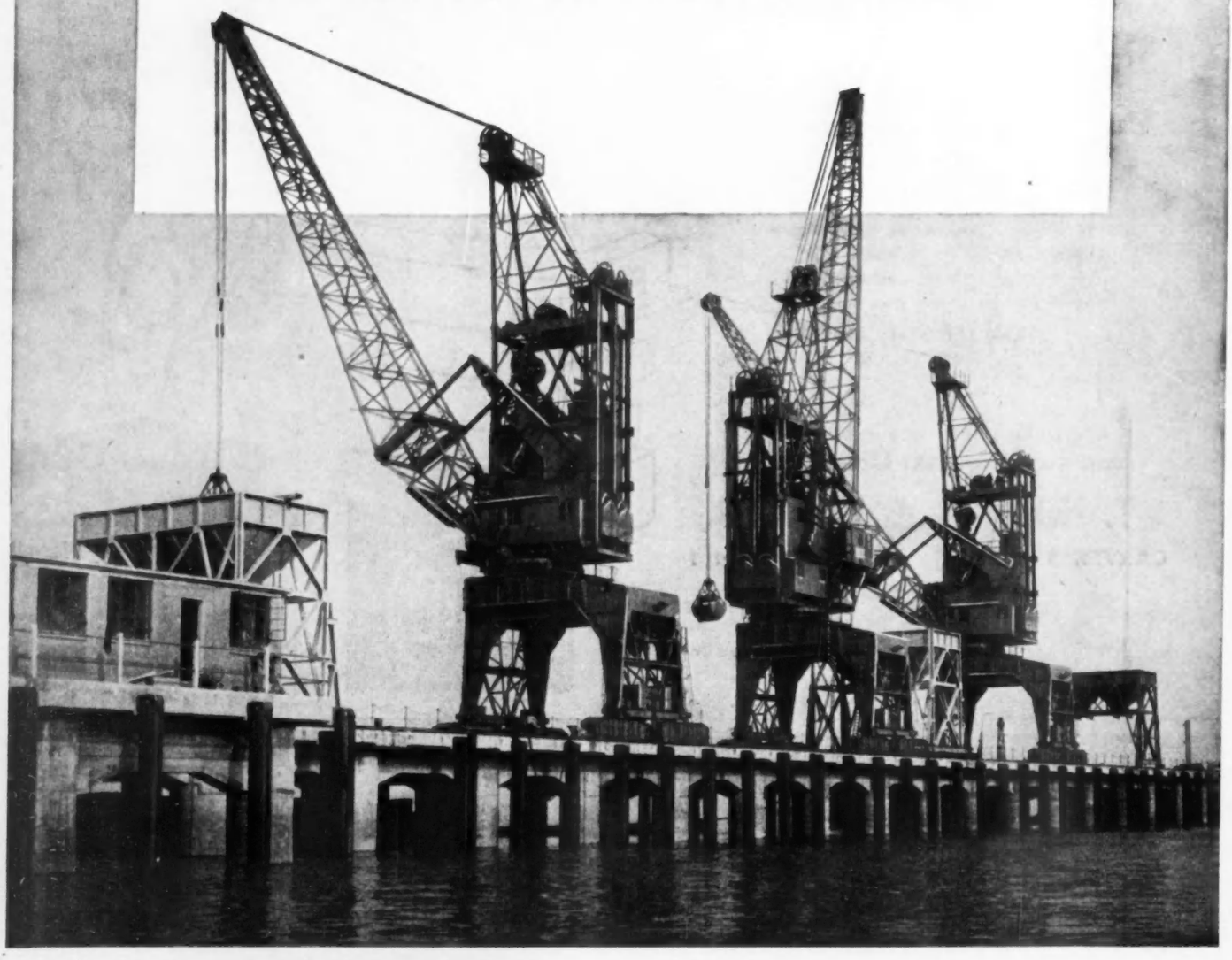
HEAVY DUTY LEVEL LUFFING GRABBING CRANES FOR RAPID DISCHARGE OF BULK CARGOES

Clyde Cranes on the new coal transfer jetty of

Messrs. William Cory & Son Ltd., on the Thames at Erith.



CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.

incorporating

Clyde Crane & Engineering Co., Mossend, Lanarkshire. Tel.: Holytown 412 (6 lines). Grams: "Clyde" Motherwell Telex. Telex 77443

Joseph Booth & Bros., Union Crane Works, RODLEY, Leeds. Tel.: Pudsey 3168 (6 lines). Grams: "Cranes" Rodley Telex. Telex 55159

R

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DO NOT PARK IN A 'NO WAITING' AREA OR CONTRARY TO WAITING RESTRICTIONS

ROAD TRAFFIC ACT 1930, Sec. 46
LONDON TRAFFIC ACT 1924, Sect. 10

MAXIMUM PENALTY FOR FAILURE TO COMPLY **£5** fine

NO WAITING

PHONE FOR M.I.L. SERVICE

- FACTORY and PLANT LAYOUT
- MACHINERY and PLANT ERECTION DISMANTLING · REMOVAL INSTALLATION · MAINTENANCE
- ERECTION and DISMANTLING OF BOILERS and CHIMNEYS
- ELECTRICAL CONTRACT WORK
- EXPORT PACKING and SHIPPING

MACHINERY INSTALLATIONS LTD 60a HIGH STREET · ACTON · LONDON · W.3
Telephone: ACORN 6044 P.B.E.

Also at: BIRMINGHAM MIDLAND 5731 P.B.E. · CARDIFF 25471 · GLASGOW CITY 6597 · NEWCASTLE UPON TYNE 22336

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HOPKINSONS' SOOT BLOWERS

FOR ONE OF THE LARGEST BOILERS IN THE WORLD

The above photograph shows one of Hopkinsons' long retracting soot blowers, with a travel of 36 feet. Blowers of this design are on order for Thorpe Marsh Power Station near Doncaster.

Hopkinsons' soot blowers are standardised to suit all types of boiler installations.

HOPKINSONS LIMITED · HUDDERSFIELD
LONDON OFFICE: 34 NORFOLK STREET STRAND W.C.2

SB/6

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There's more than Guaranteed Tensile Strength*

* *minimum: 75 tons/square inch*

in NPK Hexagon Socket Screws

GKN engineers employ up-to-date techniques to control not merely the tensile strength of NPK Socket Screws, but the *grain-flow* of the metal. In the illustration above, this grain-flow is most evident round the precision socket—where the utmost strength is needed.

At every stage in the production of NPK Socket Screws—from steelworks to stores—GKN Quality Control ensures uniformity, dimensional accuracy and good finish. NPK Socket Screws are made to engineers' standards—the highest. They are as good as they look.

NPK hexagon socket cap, set, countersunk and shoulder screws are available in a wide variety of sizes.
WEDGLOK self-locking hexagon socket screws and NPK hexagon wrenches are also available.

GKN

For price list and technical booklet write to:

GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD., Screw Division, Box 24, Heath Street, Birmingham 18. Tel: Smethwick 1441 Telex 33-239

S/S/2210

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5¼ MILLION

Operations . . .

no spares,

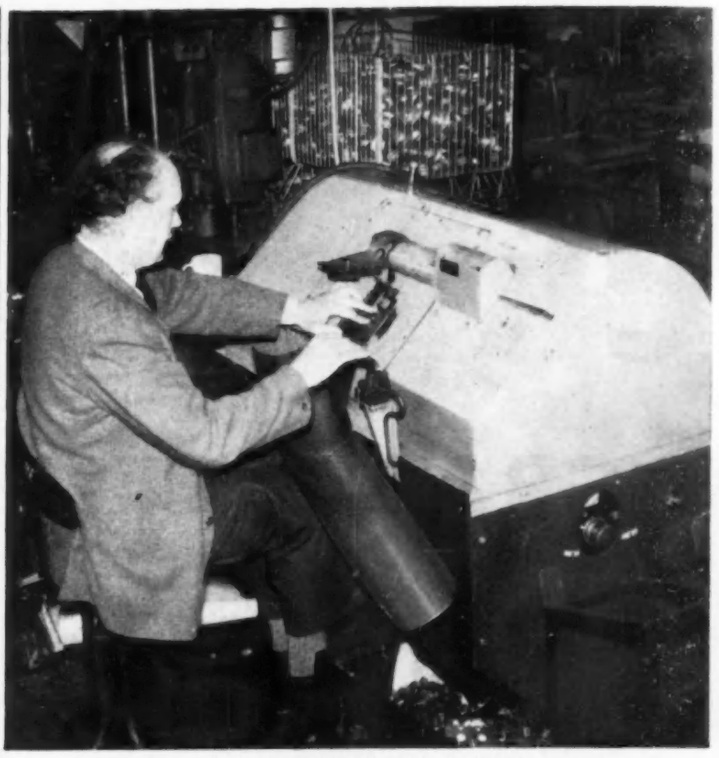
no maintenance

Here is undeniable proof that "BROOMWADE" pneumatic equipment is unsurpassed for *Efficiency* and *Reliability*.

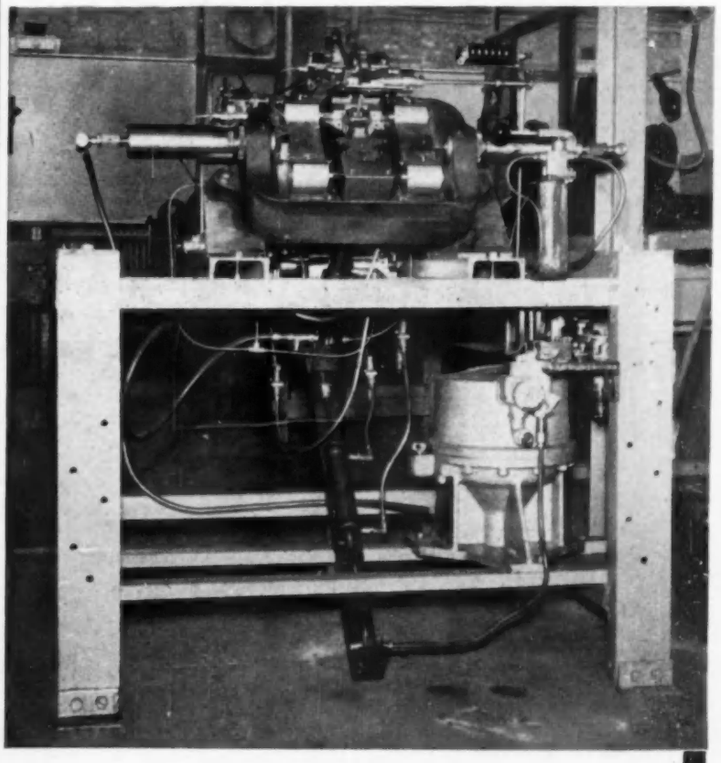
In 1955, Messrs. S. Smith & Sons (England) Ltd. installed two "BROOMWADE" Type HPS6 Squeeze Riveters with HPS5 Intensifiers. They are employed for side piercing four holes in speedometer brackets.

Each machine has performed 5¼ MILLION OPERATIONS *WITHOUT* any SPARES or MAINTENANCE. A third machine is now being installed.

You will be well advised if you discuss your compressed air problems with a "BROOMWADE" works-trained technical representative. Meanwhile, may we send you a copy of our leaflet giving full details of "BROOMWADE" Squeeze Riveting Equipment?



Two views of the "BROOMWADE" Hydro-Pneumatic equipment installed by Messrs. S. Smith & Sons (England) Ltd., by whose permission these pictures are published.



"BROOMWADE"

Air Compressors & Pneumatic Tools

YOUR BEST INVESTMENT

BROOM & WADE LTD., P.O. Box No. 7, High Wycombe, Bucks. Telephone: High Wycombe 1630 (10 lines). Telex: 83-127

793 SAS

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M

CRAVEN BROS

CRANE DIVISION LTD.

MANUFACTURERS
OF ALL TYPES OF
STEELWORKS CRANES
AND HEAVY DUTY
INDUSTRIAL CRANES

CRAVEN BROS CRANE DIVISION LTD.
LOUGHBOROUGH ENGLAND

TELEPHONE: LOUGHBOROUGH 2130

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the strength of the Ruston 'A.T.' diesel

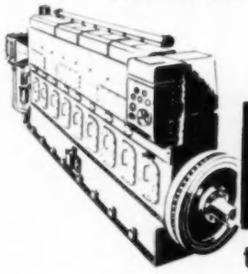
Take just two of its components . . .

The crankcase
Unique 'U'-design developed by Ruston research to give exceptional stability to bearing and crank system.

The crankshaft
The even grain of the short C.G.F. crankshaft gives a uniformity of strength unequalled by that of any other shaft.

This strength goes into every inch of the 'AT' diesel. The result is complete reliability and outstanding engine life. *Yet, in its speed and power range, the 'AT' is the most compact diesel ever produced.*

Ruston 'AT' diesels have a power range of 700-1800 b.h.p. at speeds up to 520 r.p.m. May we send technical information?



RUSTON diesels

today's most advanced diesels for all base-load and standby duties . . . 4-3100 b.h.p.

RUSTON & HORNSBY LTD · LINCOLN · ENGLAND Associated with Davey, Paxman & Co. Ltd., Colchester

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only FIRTH-VICKERS make

'Staybrite'

FDP

STAINLESS STEEL

For over 25 years 'Staybrite' F.D.P. steel has been the standard material in the construction of a wide range of chemical plant. It is also used for storage and transport in the chemical, dairy and brewing industries, and is extensively applied in all types of power production.

Technical information on the use of all Firth-Vickers steels, together with technical literature are always available on request.

FIRTH-VICKERS STAINLESS STEELS LTD., SHEFFIELD

the only Company in Europe to devote its activities exclusively to the production and development of stainless and heat-resisting steels.

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AUTOMETRIC
CENTRIFUGAL **PUMPS**

$\frac{3}{4}$" - 1$\frac{1}{2}$"

CAST IRON, BRONZE OR STAINLESS STEEL
CHOICE OF THREE MECHANICAL SEALS
send for details of this and other types

AUTOMETRIC PUMPS LTD
LOWER WATERSIDE · MAIDSTONE · KENT
TELEPHONE MAIDSTONE 4728

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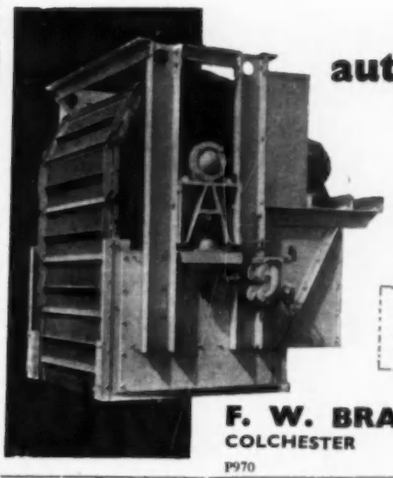

automatic screens

FOR CONDENSER COOLING
WATER · POWER STATIONS
WATERWORKS · FACTORIES
PAPERMILLS & TANNERIES

PUMPS FOR AIR
WATER & VACUUM

F. W. BRACKETT & CO. LTD.
COLCHESTER Telephone : 3958
P970 Enter No. 972 on reply card

absterge
(to clean by wiping)

Austins supply the best cleaning rags for every purpose. Some jobs call for coarse, heavy fabric, some for soft, closely woven materials—we can meet all requirements with carefully selected rags that are thoroughly washed and sterilized in our own plant. Orders of all sizes are handled with promptness and reliability. Please let us quote you for regular supplies.

AUSTINS industrial cleaning rags
E. AUSTIN & SONS (LONDON) LTD., GUN WHARF, GUNMAKERS LANE, E.3 · Tel : ADVance 1211
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METAL HANDLING MADE Easier

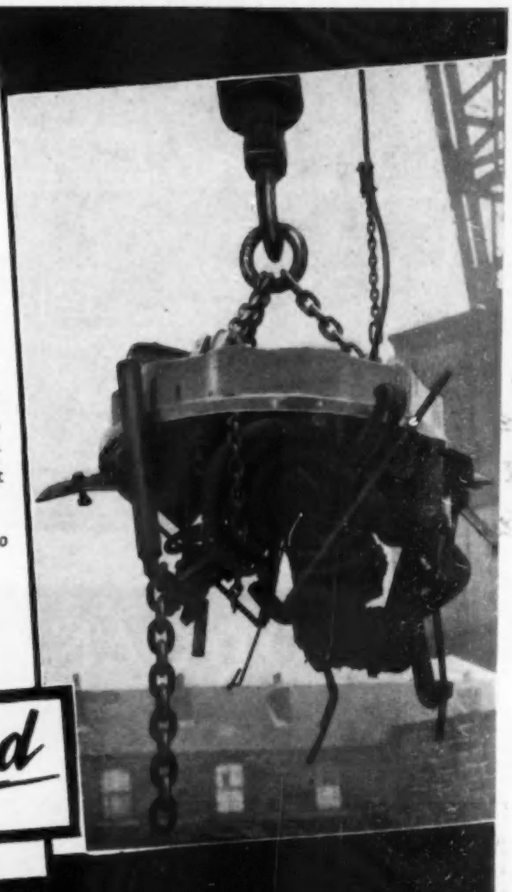
For breaking up and moving mixed steel scrap, or solid metals there is nothing to equal in performance and price, a Burnand electro-lifting magnet.

There is a wide range of sizes to satisfy every requirement and condition. Each magnet is specially treated to protect it against moisture and to assist in cooling.

Lifting magnets and control equipment also available on hire.

W. E. BURNAND & SON LTD.
Shoreham Street, Sheffield.
Telephone : 24148 (3 lines)

Burnand



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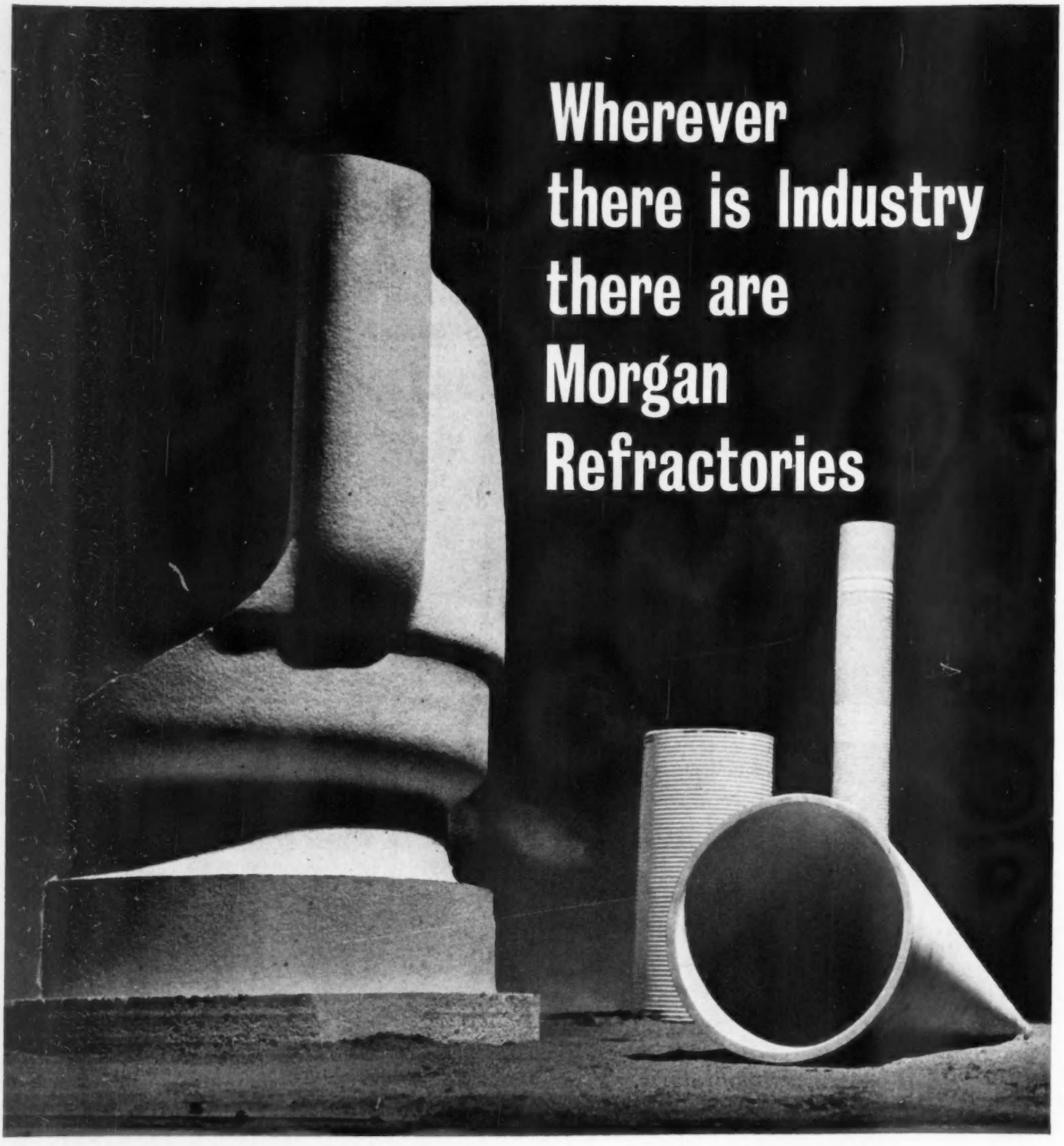

MORGAN Refractories Ltd

NESTON, WIRRAL, CHESHIRE. TELEPHONE: NESTON 1406

NE164A

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ½-page £29 10s. ¼-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ½-page £25 10s. ¼-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C. 2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

BRADFORD INSTITUTE OF TECHNOLOGY

APPOINTMENTS

Applications are invited for the following posts :

READER IN MECHANICAL ENGINEERING

Candidates should possess the qualifications and experience to direct research and post-graduate work and to take a leading part in advanced teaching. Importance will be attached to industrial and research experience. Adequate facilities will be given to undertake research and suitable technical assistance and equipment are available.

Salary : £1800 to £2100 per annum (or above in special cases).

PRINCIPAL LECTURER IN MECHANICAL ENGINEERING

Candidates should be qualified to teach to final degree and Diploma in Technology standard and should have adequate research and industrial experience. The successful candidate will be expected to assist the Head of the Department with the organisation and administrative work of the Department and will be encouraged to develop industrial contacts.

Salary : £1750 to £1900 per annum.

Previous industrial or research experience at a suitable level will be taken into account in fixing the commencing salary.

Senior members of staff are encouraged to undertake consultant work in industry and may retain fees paid for such work.

Further particulars and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford, 7.

HENRY PATTEN,
E6855 Clerk to the Governors.

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

BRUNEL COLLEGE OF TECHNOLOGY
WOODLANDS AVENUE, ACTON, W.3.

Principal : Dr. J. TOPPING, M.Sc., D.I.C., F.Inst.P.

DEPARTMENT OF MECHANICAL ENGINEERING

HEAD OF DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of HEAD OF DEPARTMENT OF MECHANICAL ENGINEERING, Grade V, which becomes vacant on 31st December, 1960, the present holder having been appointed to a Principalship.

The main work of the College is concerned with sandwich courses for the Diploma in Technology. New building for the department will be available in two years' time when it will be possible to extend considerably the post-graduate courses and research work in the department.

The post provides opportunities for a man interested in education as well as research, and in developing correlated schemes of industrial training.

Salary will be within the range : £2138 to £2301 per annum.

Further information and forms of application may be obtained from the Principal, to whom completed forms should be returned within 14 days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
E6885 Chief Education Officer.

UNIVERSITY OF QUEENSLAND

SENIOR LECTURER IN ENGINEERING

Applications are invited for the above-mentioned position in the University College of Townsville. Applicants should have a degree with honours in Engineering and should preferably have teaching experience.

Salary : £A.2520 to £A2870.

The successful applicant will enjoy the privileges of superannuation, study leave, travel grants and other benefits available to the academic staff.

Further particulars and application forms are obtainable from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 19th November, 1960. E6882

PUBLIC APPOINTMENTS

CITY OF LIVERPOOL EDUCATION COMMITTEE

CITY COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL, MARINE AND PRODUCTION ENGINEERING

RESEARCH ASSISTANT (TEMPORARY)

Applications are invited for the appointment of RESEARCH ASSISTANT (TEMPORARY) for a period of two years in the first instance. Duties to commence as soon as possible.

Salary : £645 to £815 p.a. (Grade A.P.T. I).

Applicants should possess a degree in Engineering. The person appointed will be required to carry out research under guidance on Machine Tool behaviour in the Production Engineering Section which includes Advanced Machine Tool and Metrology Laboratories. He will be encouraged to work for a higher degree or for the College Fellowship and may be called upon to demonstrate for not more than six hours per week.

Application forms (returnable by 4th November, 1960) from the Director of Education, 14 Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
(J.6446) Town Clerk and Clerk to the
E6894 Local Education Authority.

CITY OF BIRMINGHAM EDUCATION COMMITTEE

BROOKLYN TECHNICAL COLLEGE
Principal : C. A. THOMPSON

ASSISTANT GRADE "B"

Required as soon as possible, but not later than 1st January, 1961, an ASSISTANT, GRADE "B" in Machine Shop Engineering. The post has been caused by rapid expansion following the opening of a new workshop.

Applicants should be prepared to offer Workshop Practice and Theory with the appropriate ancillary subjects for City and Guild Courses 63 and 193.

Salary : £700 by £27 10s. to £1150 with additional allowances for degree and teacher training. Increments for approved industrial and teaching experience are allowed to determine the entry point to the salary scale.

Further details and application forms may be obtained from the Principal at the College, Aldridge Road, Great Barr, Birmingham, 22a, to whom completed applications must be returned by 28th October, 1960.

E. L. RUSSELL,
E6878 Chief Education Officer.

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD AND MID HERTS GROUP HOSPITAL MANAGEMENT COMMITTEE

GROUP SUPERINTENDENT ENGINEER

Applications are invited for the appointment of a GROUP SUPERINTENDENT ENGINEER who will be responsible for the engineering services of all Hospitals in the Group.

Applicants must have completed an apprenticeship in mechanical engineering and have a sound knowledge of the principles and practice of the efficient operation of steam boiler plants and have a wide experience, in a supervisory capacity, of such types of mechanical and electrical services as are found in hospitals. Candidates must have passed an examination in engineering technology and hold First-Class Certificate of Competency in Marine Engineering or an equivalent qualification.

In addition to the normal work of the Group, the successful candidate will be required to associate himself with the installation of the engineering services of the new Welwyn/Hatfield Hospital. The points count for salary purposes will be in the 50½–60 points range.

Salary scale : £1130 to £1325 per annum.

Applications, stating age, experience, qualifications and naming three referees, should be sent to the Group Secretary, Bleak House, Catherine Street, St. Albans, Herts, by 2nd November, 1960. E6798

PUBLIC APPOINTMENTS

CHESTERFIELD, BOLSOVER AND CLOWNE WATER BOARD

CHIEF ASSISTANT ENGINEER

Applications invited for the above appointment from suitably qualified persons with considerable experience in Water Supply Engineering. Salary scale J.N.C. Grade B, £1250 - £1485 + 12½% (approximately) in accordance with the recent decision of the Joint Negotiating Committee.

The appointment is next in seniority to the Engineer and Manager of the Board. Housing accommodation will be provided and a car allowance is payable on the essential user scale.

The appointment is subject to the provisions of the Local Government Superannuation Acts, 1937-1953, and will be terminable by one calendar month's notice on either side.

Forms of application and further particulars may be obtained from the Engineer and Manager, New Beetwell Street, Chesterfield, and should be returned to the undersigned not later than Monday, the 31st October, 1960.

RICHARD CLEGG,
Town Hall, Clerk to the Board.
Chesterfield. E6806

GOVERNMENT OF SIERRA LEONE

POSTS AND TELECOMMUNICATIONS DEPARTMENT

TELECOMMUNICATIONS ENGINEER

Responsible for supervising, maintaining, installing and developing telecommunications services generally including Carrier Telephony under the direction of the Postmaster-General and the Engineer-in-Chief.

Contract appointment. Salary range £1470 to £2145 a year. Gratuity 15 per cent of salary. Free passages. Rented quarters. Children's allowances. Generous leave. Candidates under 45 years should be either A.M.I.E.E. or hold a Degree or Diploma in Electrical Engineering with Telecommunications subjects. They must have a sound knowledge of theory and practical experience of telecommunications engineering generally.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience quoting BCD 108/15/03/D4.

E6871

SOUTHAMPTON CORPORATION WATERWORKS

CIVIL ENGINEERING ASSISTANT

Applications are invited for the above appointment on the permanent establishment. Salary within A.P.T. Special Grade (£840 to £1145), according to qualifications and experience.

Housing accommodation available in approved cases and approved removal expenses reimbursed up to a maximum of £50.

Applicants should not be more than 35 years of age and must have passed Parts 1 and 2 Institution of Civil Engineers or exempting examination. Experience in Waterworks advantageous.

Conditions of appointment and form of application from C. A. Bradley, B.Sc., M.I.C.E., Waterworks Engineer and Manager, Civic Engineer, Southampton. Applications by Saturday, 12th November, 1960.

Civic Centre,
Southampton. E6889

CIVIL SERVICE COMMISSION

PATENT EXAMINERS AND PATENT OFFICERS

PATENT EXAMINERS AND PATENT OFFICERS. Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 29 (36 for Examiners), with extension for regular Forces service and Overseas Civil Service. Qualifications : normally first or second class honours degree in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. London salary (men) : £655 to £1460 ; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/128/60, and stating date of birth. E6864

PUBLIC APPOINTMENTS

LEICESTER NO. 1 HOSPITAL MANAGEMENT COMMITTEE

THE LEICESTER ROYAL INFIRMARY
(506 BEDS)

SENIOR ENGINEER

Applications are invited for the post of SENIOR ENGINEER to be responsible to the Superintendent Engineer for the satisfactory operation and maintenance of the mechanical and electrical services at The Leicester Royal Infirmary (506 beds). Candidates should have completed an apprenticeship in mechanical engineering, or otherwise have acquired a thorough practical engineering training as distinct from a purely craft training.

Preference will be given to candidates having either a Ministry of Transport and Civil Aviation First Class Certificate of competency in Marine Engineering, or a Certificate of Service as First Class Engineer, or a City and Guilds Technical certificate in Plant Engineering (First Class), and have had previous experience in a supervisory position of hospital or similar mechanical and electrical services ; and have a sound knowledge of the principles and practice of the efficient operation and maintenance of steam boilers, engines and other plant.

The salary will be on the scale of £715 rising by annual increments to £855 per annum, abated by £30 if without the requisite qualifications. The person appointed may be required with other engineers to take part in an "On Call" rota. A house is available if required.

Applications, stating age, qualifications and experience, and naming three referees to : Group Secretary, Leicester No. 1 Hospital Management Committee, The Leicester Royal Infirmary, within fourteen days of the appearance of this advertisement. E6850

MINISTRY OF LABOUR

GOVERNMENT TRAINING CENTRE, LETCHWORTH, HERTS.

INSTRUCTOR (UNESTABLISHED)

Ministry of Labour require General Fitter for appointment as INSTRUCTOR (UNESTABLISHED) at Government Training Centre, Letchworth, Herts. Applicants must be British subjects who are experienced and fully skilled, able to teach their trade, and supervise the work, and maintain control of the trainees in their trade. They should have undergone training usual in their trade followed by at least 5 years practical experience, and should preferably possess O.N.C. or City and Guilds Certificate or equivalent qualifications where appropriate. Prospect of eventual establishment. Commencing salary (at age 30 and over) £930 rising by two annual increments to £1000 p.a. Write for application form within 7 days to Employment Exchange, Letchworth, Herts. Selected applicants will be required to pass a Theoretical Test before appointment and a practical test of normal trade skills after taking up appointment. E6865

MANCHESTER REGIONAL HOSPITAL BOARD

MAIN GRADE ENGINEER

Manchester Regional Hospital Board invite applications from qualified mechanical and/or heating and ventilating engineers for two posts of MAIN GRADE ENGINEER. Salary scale : £910 by £35 (1) by £40 (2) by £45 (5) by £50 (7) to £1600. National Health Service conditions and superannuation scheme. Application forms obtainable from the Secretary, Manchester Regional Hospital Board, Cheetwood Road, Manchester, 8, to whom they should be returned by 14th November, 1960.

E6847

CITY OF MANCHESTER

MECHANICAL ENGINEER

MECHANICAL ENGINEER required in the Rivers Department. A.P.T. IV (£1140 to £1310). Applicants should be qualified engineers with sound knowledge of both mechanical and electrical engineering and practical workshop experience ; knowledge of maintenance of sewage works machinery and power generation plant advantageous. Details from, and applications to, General Manager, Rivers Department, P.O. Box 488, Town Hall, Manchester 2. Closing date 27th October, 1960. E6846

Classified Advts. continued on page 100

PUBLIC APPOINTMENTS

MINISTRY OF LABOUR

GOVERNMENT TRAINING CENTRE, SLOUGH, BUCKS.

DRAUGHTSMAN ASSESSMENT COURSE INSTRUCTOR (UNESTABLISHED)

Ministry of Labour require Engineer for appointment as a DRAUGHTSMAN ASSESSMENT COURSE INSTRUCTOR (UNESTABLISHED) at Government Training Centre, Slough, Bucks. Applicants must be British subjects with a wide experience in the operation of machine tools and who possess good general fitting knowledge. They must be fully skilled, able to teach their trade, and supervise the work and maintain control of trainees in their trade. They should have undergone training usual in their trade followed by at least 5 years practical experience, and preferably possess O.N.C. of City and Guilds Certificate or equivalent qualifications where appropriate. Prospect of eventual establishment. Commencing salary (at age 30 and over) £930 rising by two annual increments to £1000 p.a. Write for application form within 7 days to Employment Exchange, Slough, Bucks. E6866

UNITED LIVERPOOL HOSPITALS

ENGINEERING ASSISTANT

Applications are invited for the post of ENGINEERING ASSISTANT to assist the Superintendent Engineer. The duties will include the preparation of drawings and specifications. Candidates should be competent draughtsmen and experienced in heating and ventilating and general engineering work and should hold the Higher National Certificate in Mechanical Engineering or its equivalent. The salary is on the scale £600 by £25 (6) by £30 (3) to £840 per annum and a candidate with suitable experience may enter the scale above the minimum. The Terms and Conditions of Service are those of the appropriate Whitley Council.

Apply, stating age, qualifications, experience and the names and addresses of three persons to whom reference may be made to the Secretary, The United Liverpool Hospitals, 80, Rodney Street, Liverpool, 1, by the 8th November, 1960. E6881

BURNLEY AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

SUPERINTENDENT ENGINEER

Applications are invited for the position of SUPERINTENDENT ENGINEER, who will be responsible for the satisfactory operation, maintenance, and co-ordination of the engineering services and activities, both mechanical and electrical, of the Group of Hospitals ; the supervision of engineering maintenance works, and the keeping of all necessary records, &c.

Applicants should be qualified in accordance with the Ministry of Health requirements.

Salary : £1070 by £30 (2) by £35 (3) to £1235.

Applications, giving details of qualifications and experience, together with the names and addresses of two referees, should be received by the Group Secretary, Burnley General Hospital, not later than the 31st October, 1960. E6884

TENDERS

COUNTY BOROUGH OF WARRINGTON

WATER DEPARTMENT

TENDERS FOR PUMPING EQUIPMENT

The Council invite TENDERS on a FIXED PRICE basis for the following PLANT and EQUIPMENT :

HOUGHTON GREEN PUMPING STATION

Contract No. 1—The SUPPLY and ERECTION of Submersible Well Pumps, Horizontal Centrifugal Pumps, Electrical Switchgear and Hydraulic Instruments.

RISLEY PUMPING STATION

Contract No. 2—The SUPPLY of Small Horizontal Centrifugal Pumps, Air Compressor and Pressure Vessel.

Specifications, Conditions of Contract and Form of Tender may be obtained from the Water Engineer, Water Department Offices, Pinners Brow, Warrington. Tenders in sealed envelopes appropriately endorsed should be delivered to the undersigned at the Town Hall, Warrington, not later than noon on the 31st October, 1960.

When applying for Tender documents, tenderers are requested to indicate for which of the above contracts information is required.

The Council do not bind themselves to accept the lowest or any Tender.

J. P. ASPDEN,
Town Clerk.

E6859

EDUCATIONAL

UNIVERSITY OF SHEFFIELD

FAILURES IN MACHINES AND STRUCTURES

A COURSE OF ELEVEN LECTURES, with discussion, on failures in a wide range of branches of mechanical engineering, Tuesday to Friday, 25th to 28th October

Apply to Professor W. A. Tuplin, Applied Mechanics, University, St. George's Square, Sheffield 1 E6773 E

EDUCATIONAL

A.M.I.MECH.E., B.SC., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page, prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 F

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A HEATING, VENTILATING AND LIGHTING ENGINEER is required to augment the specialist services now provided by PERA. The successful applicant will act as an adviser in these subjects to firms throughout the country, and will carry out his assignments at the various Companies. Applicants should be conversant with boiler efficiency tests and the specification of factory services systems. Essential qualities include enthusiasm and ability to work on own initiative. Superannuation under F.S.S.U.—Send details of training, experience and present salary to Secretary (I.751), Production Engineering Research Association, Melton Mowbray, Leics. E6868 A

AIR CONDITIONING ENGINEER EAST AFRICA

Required in Nairobi, an AIR CONDITIONING AND REFRIGERATION ENGINEER for Sales and Engineering work using American and other equipment. Considerable experience of the Design and Installation of this type of plant essential together with genuine interest in sales. Starting salary in region of £2500 per annum is offered with generous conditions of employment and good prospects for advancement. Free passages and substantial U.K. leave.—Reply in the first instance, giving details of age, experience and qualifications to BOX No. E6887, "The Engineer," Interview London.

A

APPLICATIONS ARE INVITED for an appointment as a MECHANICAL ENGINEER in a large factory in Central Scotland for Maintenance and Development work on heavy plant ; candidates should have a degree or equivalent qualification and some experience in work of a similar nature ; interesting work, prospects of advancement, Staff Pension Scheme.—BOX No. E6848, "The Engineer." A

ASSISTANT to Company Works' Engineer required to work from London office. Some travelling involved. Age 25-30. H.N.C. Mechanical. Able to work on own initiative.—Apply BOX No. E6858, "The Engineer." A

ASSISTANT ENGINEER for Sheffield Steel Works. Applicants should have experience with : Steel Melting Plant, Rolling Mills, Forges, Steam and Hydraulic Engineering.—Write, stating qualifications and experience to Box E803, c/o Streets, 110, Old Broad Street, E.C.2. E6892 A

ASSISTANT CHIEF INSPECTOR, aged 30-35, required for Engineering Company. Must be in possession of full City and Guilds qualification and have served engineering apprenticeship (including Drawing Office training). Previous Inspection experience an advantage but not essential.—Applications, quoting full particulars of age, education, training and salary, to BOX No. E6883, "The Engineer." A

COLGATE PALMOLIVE LIMITED
invite applications for
DESIGNER/DRAUGHTSMAN
at H.N.C. level with experience in general mechanical engineering, including plant layout and design, pipework and service systems and pressure vessel design. Knowledge of chemical plant an advantage. Work is interesting and varied under ideal conditions.—Applications, giving details of age, qualifications, training, experience and salary expected, should be sent to Personnel Manager, 371 Ordsall Lane, Salford 5.

E6895 A

CONVEYOR DESIGN

SENIOR DESIGN DRAUGHTSMAN with extensive experience in all types of Conveyor required for a new factory near Bombay.

Three years contract with passages paid for family and free furnished accommodation. Salary up to £2500 per annum depending on experience.

Apply BOX No. E6796, "The Engineer."

A

DIRECTOR OF TRADE ASSOCIATION

Applications are invited for the position of on a full or part-time basis of a National Engineering Contractors' Association, whose work is allied to the Building Industry. The Director would be responsible for commercial and labour negotiations at high level with Government Departments, Local Authorities and Trade Unions Officials and would be expected to promote the Association's interests.

Applicants should be about 40-50 years of age, and will be offered an attractive salary commensurate with their qualifications and experience.

In considering an applicant on a part-time basis, it is essential that the Association should have prior call on his services.

Applications will be treated in strict confidence, and should be submitted to BOX No. E6752, "The Engineer" by November 1st, 1960. A

SITUATIONS VACANT

DRAUGHTSMAN required with or desiring experience in railway carriage and wagons or diesel traction. Man with good general or structural engineering experience considered. Superannuation scheme in operation. Salary commensurate with qualifications and experience.—Apply The Secretary, The Birmingham Railway Carriage & Wagon Co. Ltd., Smethwick, 40, Staffs.

E6803 A

ENGINEER SURVEYORS for inspection of Cranes and Lifting Plant required. Must have drawing office experience of design of Cranes, also National Certificate Mechanical Engineering. Essex and Liverpool areas. Permanent. E.S.A. Scale salary, commencing £800 p.a. Other benefits.—Apply Eng. Dept., General Accident Assurance Corp. Ltd., 99, Aldwych, W.C.2. E6862 A

ENGINEER SURVEYORS for inspection of Boiler and Pressure Plant required. Applicants must not be more than 38 years and must have 1st Class M.O.T. certificate with steam endorsement or equivalent qualifications. Salary (E.S.A. Scale) starting at £1800 p.a. Other benefits. Areas : Oxford, Reading, Windsor,—Apply Eng. Dept., General Accident Assurance Corp. Ltd., 99, Aldwych, W.C.2. E6861 A

ENGINEERING GRADUATES.—The Atomic Energy Division of the G.E.C. invites applications from Engineering Graduates, less than 30 years of age, interested in the basic design and analysis of complex steel structures, stress analysis of shells, evaluation of temperature stress distributions, creep and pipework calculations. Previous experience of some aspects of this work is desirable though not essential, and it is envisaged that successful candidates would have an honours degree in mechanical or civil engineering.—Write Personnel Manager (DWB), The General Electric Company Limited, Erith, Kent. E6893 A

ENGINEERING INSURANCE. Applications are invited from Engineers, not over 35 years of age, who have served an apprenticeship and have a sound theoretical and practical knowledge of cranes and lifting machines and are technically qualified to Higher National Certificate standard, for a vacancy in the Taunton area. The position is permanent, pensionable, with salary scale £800 rising to £1100 per annum, plus other expenses and allowances.—Apply in own handwriting to BOX No. E6793, "The Engineer." A

ENGINEERING INSURANCE COMPANY invites applications from Engineers not over 35 years of age who possess First Class M.O.T. Certificate (Steam) for position as MECHANICAL ENGINEER SURVEYOR in Swansea and surrounding areas. Progressive salary scale commencing at £800 rising to £1100 per annum plus other expenses and allowances. Non-contributory pension scheme.—Apply in own handwriting to The Northern Assurance Company Limited, 1, Moorgate, E.C.2. E6854 A

ENGINEERING INSURANCE. Applications are invited from Mechanical Engineers not over 35 years of age, who having served an apprenticeship with Crane and Lift Makers have a sound theoretical and practical knowledge of Cranes, Lifts, Lifting Machines and their maintenance, and are qualified to Higher National Certificate standard, for a vacancy as ENGINEER SURVEYOR based in the Stoke-on-Trent district. The position is permanent, pensionable, with salary scale of £800 rising to £1100 per annum, plus expenses and allowances.—Apply in own handwriting to BOX No. E6877, "The Engineer." A

F. R. BULLEN & PARTNERS, Consulting Engineers, require for their Glasgow and Darlington offices detailers experienced in reinforced concrete or structural steelwork.—Applications in writing should be sent in the first instance to Dacre House, Dean Farrar Street, Westminster, London, S.W.1. E6727 A

FORENSIC ENGINEERS invite application for ENGINEERING GRADUATES with good background and industrial experience for responsible and individualistic post. Age not over 35.—BOX No. E6835, "The Engineer." A

FOUNDRY SUPERINTENDENT

required for small ferrous and non-ferrous foundry at a Gold Mine in Ghana. This is a jobbing foundry with a current production of only 20 tons per months and it is desired to increase the production and effect improvements to produce better quality casting. Applicants should be qualified to L.I. Metallurgy or hold H.N.C. in Metallurgy with at least 5 years' shop floor experience.

Starting salary around £1500 p.a. but depending on qualifications and experience.

Fifteen months foreign tours followed by 3 months' paid leave. Continuous contract. Passages for applicant and wife and housing provided. Pension Scheme.—Write to BOX No. E6863, "The Engineer."

A

INSPECTION ELECTRICAL ENGINEER required for Manchester area. Applicants should be between 25 and 40 years of age with minimum qualification O.N.C. and with some inspection experience.—Reply to BOX No. E6852, "The Engineer," giving essential data and salary required.

INSPECTION ELECTRICAL ENGINEER required for London area. Applicants should be between 25 and 40 years of age with minimum qualification O.N.C., and with some inspection experience.—Reply to BOX No. E6851, "The Engineer," giving essential data and salary required.

INSPECTION ENGINEER—Electrical—required by North East Firm. Applicants should be between 25 and 40 years of age and be prepared to travel. Minimum qualification O.N.C. and preferably with some inspecting experience.—Please reply to BOX No. E6853, "The Engineer," giving essential data and salary required. A

MECHANICAL DRAUGHTSMAN required by large industrial organisation at its London Head Office. Applicants must have good mechanical knowledge with particular reference to refrigeration and air conditioning. Some experience of layout and detailing of food processing machinery would be an advantage. Good salary. Non-Contributory Pension Scheme.—Write, giving age and details of experience to BOX No. E6860, "The Engineer." A

SITUATIONS VACANT

JACKSON INDUSTRIES LIMITED
Dallow Road, LUTON,
require
SENIOR DRAUGHTSMAN FOR WORK ON ELECTRICAL DOMESTIC APPLIANCES
Experience of these products would be an advantage and knowledge of sheet metal fabrications would be useful.
ALSO
SENIOR JIG AND TOOL DESIGNER
required
for work on press tools and mass production pipework jigs.

E3032 A

MANAGER for medium-sized Engineering Works in S.E. London. The post will entail responsibility for Production, Design and Drawing Office and Works Administration. The person appointed should be 30-35 years old and have sound technical and practical knowledge of M.S. Fabrications, Machining, Fitting and Assembly Work. Experience of Hydraulic Press construction and/or Stainless Steel and Aluminium fabrications would be an added qualification.—Write, giving full details of experience, qualifications and salary to BOX No. E3028, "The Engineer." A

MECHANICAL ENGINEER required, aged 25-35. Applicants should have a good University Degree in Mechanical Engineering with some workshop and plant construction experience. Alternatively, those having served a recognised apprenticeship with a reputable Engineering firm will be considered, if this is supported by good general education. Such applicants should have technical qualifications to at least Higher National Certificate standard and should be able to produce some evidence of having had responsibility for even minor installations. Knowledge of Chemical Engineering design will be an advantage. The post carries sound prospects and is with a factory in the extreme East London area.—Fullest information and salary required to BOX No. E3035, "The Engineer," marking the envelope for the attention of the Chief Engineer. A

MECHANICAL OR PRODUCTION ENGINEER with highly developed qualities of leadership and initiative, and experience in writing or editing technical reports required to take charge of a translation group at a well known and rapidly expanding organisation in the East Midlands. This appointment offers very considerable scope for development in addition to a good starting salary, excellent superannuation scheme, and pleasant surroundings.—Send full details of present salary, training and experience, quoting I.750 to BOX No. E6867, "The Engineer." A

PROMINENT BRITISH COMMERCIAL FIRM requires experienced SALES ENGINEER holding Graduate or Associate Membership of one of the professional institutions and aged about 30 for the position of Head of the Import/Engineering Department of one of its overseas branches. The Department is responsible for the import of a range of engineering products manufactured by U.K. and European Principals, and requires good technical knowledge and an energetic outlook. An excellent salary is offered, together with other substantial benefits, including furnished accommodation at nominal rent, frequent paid home leave with paid passages, outfit allowance, &c.—BOX No. E6891, "The Engineer." A

SECTION LEADER/DESIGN DRAUGHTSMAN required for work on wide range of air handling equipment for commercial and aircraft use. Familiarity with aircraft procedure essential, some electrical experience desirable. Pension, good conditions and amenities. Salary appropriate to experience and responsibility.—Preliminary details to D.O. Manager, The Airscrew Co. & Jicwood Ltd., Weybridge, Surrey. E3034 A

SENIOR DRAUGHTSMEN

required with experience of jig and tool work and light machinery employing electrical, pneumatic and hydraulic systems. Interesting work in Modern Office. Fluent written and spoken English an advantage.—Please send full details to Director of Engineering, Edward Pryor & Son, Ltd., Broom Street, Sheffield, 10.

E3037 A

SENIOR DRAUGHTSMAN required—fully experienced in the design of pressure vessels and general fabrications—good salary and conditions in an expanding company—assistance with housing if required.—Apply : General Manager, Northern Welding Co. Ltd., Weedon Road, Northampton. E3040 A

TECHNICAL AUTHOR required not over 50, to undertake the compilation of operating and maintenance instruction manuals dealing with the Company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer with a bias towards technical writing. —Applications should be addressed to the Personnel Manager, Molins Machine Company Ltd., Evelyn Street, London, S.E.8.

E6733 A

TRAINEE ASSISTANT wanted for Engineering Department of food manufacturing company in East Anglia. Engineering degree or Associate Membership of Institute of Mechanical Engineers or similar qualification essential. Candidates should have some practical experience, and if possible, have held some position of responsibility. Age not over 35. Vacancy should be of interest to technical men wishing to widen their experience on the production side.—Apply, stating age, qualifications, experience and salary required, to BOX No. E3036, "The Engineer." A

TWO EXPERIENCED DRAUGHTSMEN invited to apply for positions in expanding company in East Midlands. One required for design of Press Tools, and one for design of Automatic Lathe Tooling, &c. The prospects are good.—Applications, giving details of age, experience, salary required, to The Manager, BOX No. E6842, "The Engineer." A

BOOKS and PUBLICATIONS

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The text of this book is founded on lectures given to University and Higher National Certificate engineering students. It will serve those studying for the examinations of the Institution of Mechanical Engineers in Industrial Administration and of the Institution of Production Engineers (Part III).

The main changes in this edition are occasioned by new Acts of Parliament and corresponding organizational changes in industry. The bibliography and problems have also been revised.

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SITUATIONS VACANT

THE VULCAN BOILER & GENERAL INSURANCE CO. LTD. have a vacancy for a LIFT AND CRANE ENGINEER SURVEYOR in the London area. Applicants should possess a Higher National Certificate in Mechanical Engineering or a First Class M.O.T. Certificate (Motor). Age about 30 years. Commencing salary £800 rising to £1000 per annum. Non-contributory pension scheme.—Applications to 67, King Street, Manchester, 2. E6844 A

THE PULSOMETER ENGINEERING COMPANY LIMITED
READING, BERKS.

Applications are invited from Engineers to following appointments :

(1) TEST SUPERINTENDENT to take full charge of a test department dealing with a wide range of centrifugal pumps driven by A.C. and D.C. motors, diesel engines and steam turbines. Applicants must have had sound technical and practical training and previous experience in a similar capacity. Technical education to H.N.C. standard.

(2) ENGINEER ASSISTANT in the Technical Department. He will be required to work in close collaboration with the Test Superintendent, to check and analyse test results, and to issue instructions for any modifications needed. He will also be required to keep Sales and Estimating Departments supplied with up to date information regarding pump performance.

Applicants must have knowledge of the design and performance of all types of centrifugal pump.

Minimum technical education to H.N.C. standard.

Applicants should be between 25 and 40 years of age, and should submit full particulars of training and experience, and salary required, to the Assistant Secretary. Suitable applicants will be required to attend for an interview at Reading.

E6856 A

WESTERHAM PRESS LTD. have an interesting vacancy for a young ENGINEER frustrated by lack of opportunity and seeking a position calling for imagination and drive. Applicants must have good basic knowledge of all printing processes and plant, and should be interested in electronics and coming developments in printing. Flat available.—Apply : Works Manager, The Westerham Press Ltd., High Street, Westerham, Kent. E6886 A

WORKS ENGINEER. Required by a nationally known Company for their Lancashire Factory, a Works Engineer to take full charge of the maintenance of Plant and Buildings. Applicants should have had previous experience in the maintenance of small to medium size Machine Tools, and general Factory Maintenance, and would be required to live in the district.—Write in confidence, giving age, details of experience, and salary required to BOX No. E3038, "The Engineer." A

GLACIER METAL CO. LTD.,
KILMARNOCK, Ayrshire,

invite applications for the position of

FACTORY ENGINEERING MANAGER

This is a newly created position, subordinate to the Technical Manager, which seeks to bring under a unified command technical development, work study and work measurement activities.

The Factory Engineering Manager leads a team of Engineers whose main responsibilities comprise :

1. Undertaking specified development projects, primarily in mechanical engineering, but also extending into metallurgical and electro-chemical fields.

2. Examining plant, equipment, methods, techniques, routines, etc. which constitute the 'technical' resources of the factory ; evaluating their effectiveness and suitability and, where appropriate, making recommendations for improvement.

3. Preparing standards of performance for production departments in order to establish realistic measures of efficiency.

The ideal applicant is likely to be between 28-38 years of age. He will have an Engineering Degree or equivalent qualification ; several years' experience of managing engineering development work ; experience and/or training in Work Study ; some knowledge of metallurgical and electro-chemical processes. He will be capable of deputising for the Technical Manager and have promotion potential.

Consideration will, however, be given to suitably qualified Engineers whose level of attainment falls slightly short of the ideal.

A salary range of £1350-£1850 is envisaged for this appointment with a starting salary related to age, qualifications and experience. The general conditions of employment are attractive and there are good prospects of advancement to higher level appointments in the Company.

Applications, containing brief reference to relevant data and current salary, to Personnel Manager, Glacier Metal Co. Ltd., Kilmarnock, Ayrshire.

E6874 A

SITUATIONS VACANT

ASSISTANT WORKS ENGINEER
required

Candidates must have served a practical apprenticeship in a medium engineering industry, with subsequent drawing office training. Essential qualifications are as follows :

(*a*) Experience in Machine Tools, Steam, Electrical and Heating Plant installation and maintenance, also factory and office lay-out.
(*b*) Ability to control staff.
(*c*) Technical qualifications to H.N.C. Standard, or equivalent.

Applicants should be keen, energetic, and adaptable, and preferably aged 35-45 years. Those who replied to a similar advertisement recently need not re-apply, as their applications will be re-considered.

Contributory Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary required and quoting Ref. H.A.L./141/ENG should be addressed to :

The Personnel Manager,
HUNTING AIRCRAFT LIMITED,
Luton Airport,
Beds. E6824 A

U.K.A.E.A.

Engineers & Technical Officers

are required by the United Kingdom Atomic Energy Authority in its Engineering Branch at Risley, near Warrington, on duties associated with the supply and inspection of plant and equipment within the following fields:

Estimating the costs of large construction projects involving civil, mechanical and electrical engineering and the subsequent control of approved expenditure. (Ref. 402a/J1.)

Inspection and Progressing of a wide and often novel variety of plant and equipment under manufacture at contractors' works. Close liaison with design and construction will be involved as well as considerable travelling within the United Kingdom. (Ref. 402b/J1.)

All applicants must have served a recognised engineering apprenticeship and have had wide experience in one of the fields described above together with a knowledge of engineering markets and modern techniques of manufacture, fabrication, installation and cost control in medium or heavy engineering.

For engineer posts corporate membership of a senior engineering institution is essential.

For technical officer posts possession of an appropriate O.N.C., or equivalent, may be an advantage.

Salaries will be assessed on the following scales according to age, qualifications and experience.

Engineers - £1370-£1825
Technical Officers - £1015-£1160

Housing Assistance Schemes. Contributory Superannuation.

Send postcard for application form, quoting appropriate reference to :

The Appointments Officer,
U.K.A.E.A.
Development and Engineering Group, Risley, Warrington, Lancashire.

Closing Date : 7th November, 1960.

E6836 A

Classified Advts. continued on page 102

SITUATIONS VACANT

ELECTRICAL ENGINEER

An important British Gold Mining Company in Ghana wishes to appoint an Electrical Engineer. The successful candidate will be responsible to the Chief Engineer for the maintenance of all electrical plant and machinery on the surface and underground and for the installation of all new electrical equipment. He should have experience in power generation and distribution and in the maintenance of records and ordering of spares. Previous Mining Engineering experience essential ; technical qualifications at least up to H.N.C. (Electrical) standard.

STARTING SALARY NOT LESS THAN £1,750 per annum

Tours abroad are for 15 months followed by 3 months' paid leave, passages and housing provided. The post is healthy and suitable for children. The appointment is permanent and pensionable. Income Tax at low local rates.

Applications, which will be treated in confidence, should give details of technical training, practical experience and positions held and should be addressed to BOX No. E6843, "The Engineer." A

SITUATIONS VACANT

COURAGE AND BARCLAY LIMITED'S

Group Engineering Department

has vacancies in its design and development office for (i) an ENGINEERING ASSISTANT and (ii) a GENERAL ENGINEERING DRAUGHTSMAN. Age between 25 and 35. Minimum qualifications (i) H.N.C. (ii) O.N.C. in Mechanical Engineering—or equivalents. Apprenticeship, Works and D.O. experience in the brewery and/or soft drinks industry an advantage, but not essential. Activity is not limited to the office and this leading brewery offers excellent opportunities for men of lively and versatile outlook. Starting salaries between £850 and £1150 depending on qualifications and experience.—Apply with full details to Staff Manager, Courage and Barclay Limited, Anchor Brewhouse, Horselydown Lane, London, S.E.1.

E6869 A

SITUATIONS VACANT

MECHANICAL ENGINEER

A large National Company has a vacancy for a Mechanical Engineer in each of the following centres :

London
Cardiff
Glasgow
Manchester
Wolverhampton

The Company is an expanding one and future prospects are very bright. The need is for good calibre men aged 28/30 with experience in the heavy engineering of chemical fields. Candidates should preferably have at least an H.N.C. in Mechanical Engineering, or M.O.T. 1st Class Certificate (Steam and Diesel) supported by an engineering apprenticeship.

Please send details to BOX Newspaper.

E6849 A

SITUATIONS VACANT

PRODUCTION MANAGEMENT S. WALES

Assistant to Plant Manager

This new senior production appointment is to be made to the management staff of the South Wales factory of an expanding company prominent in the manufacture of synthetic resins.

Its initial responsibilities will include :—

1. The co-ordination of stock control, supply and distribution procedures for raw materials and finished products.

2. The co-ordination of production planning and control.

3. Production development related to new and existing plant manufacturing procedures, and handling methods.

Applicants for this position should be graduates in the age range 25-35 who have a good knowledge of chemistry and/or engineering, and experience of production management work preferably in the synthetic resin industry. Please write to BOX No. E6872, "The Engineer" A

GRADUATE ENGINEERS

A very large British company concentrating on design and development as well as on production in this country and abroad, requires additional Graduate Engineers due to expansion. The work is varied and interesting and covers a very wide range. Current vacancies provide splendid opportunities for able and ambitious men to join a first-rate company where qualities of initiative are highly regarded. In addition to technical qualifications, particular attention is paid to personality and potential managerial ability. Excellent training facilities are available to enable men of the right quality to advance high in the Company's service.

There are vacancies in design, development, construction, electrical work, instrumentation, estimating, Works Engineering, and Engineering Services.

Applications will be considered from those who have recently graduated, or have completed a post-graduate apprenticeship, or from those graduates who have already had a few years' experience in industry. Age limit 22/30. Starting salaries up to £1,500 will be paid, according to age, experience and qualifications. The company assists married men with removal.

The Company is seeking men of ability and promise and only those who are confident that they have the necessary qualities should apply. *Reference Number* 116.

Please reply in confidence quoting Reference Number to :—

Robert Clive (Consultants) Limited

27, ALBEMARLE STREET, LONDON, W.1.

E6840 A

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

If you are an experienced SCIENTIST or ENGINEER and think that you may be interested in a SENIOR POST (salary from £3000 upwards) with the United Kingdom Atomic Energy Authority, you can learn more about the opportunities available, without committing yourself to making a formal application, by making use of the Authority's

CONSULTATION SERVICE

Arrangements can be made for an Informal and confidential interview

by telephoning or writing to Mr. H. S. Hoff, Personnel Consultant, U.K.A.E.A., 11, Charles II Street, London, S.W.1. (Whitehall 6262)

The more relevant detail about yourself that you can supply in advance—qualifications, experience, age, etc.—the better.

The interview will be entirely confidential. The Authority will take no further action unless you ask them to do so.

Mr. Hoff will be available for consultation in Canada in January, and in the U.S.A. in April.

E195 A

CENTRAL ELECTRICITY GENERATING BOARD

Southern, South Western and South Wales Region

RESEARCH and DEVELOPMENT DEPARTMENT PORTISHEAD, BRISTOL

Applications are invited for the following posts based at new laboratories which have recently been set up at Portishead, ten miles west of Bristol.

NON-DESTRUCTIVE TESTING ENGINEER

Regional Vacancy No. 88

A Non-Destructive Testing Engineer is required on work which will involve the appraisal of new non-destructive techniques for use on the Board's system, the devising of new techniques, the construction of prototype instruments and their development into a form suitable for site use.

Applicants should hold qualifications leading to Corporate Membership of a senior professional institution and be experienced in the application and development of non-destructive testing techniques, in particular, ultrasonic and magnetic methods. A knowledge of electronics is desirable.

The salary for this post will be within the ranges:
£1200 to £1720 (Grades 7 to 5)

There is a contributory pension scheme and good opportunity for promotion within the Board's Research and Development Departments. Assistance may, under certain conditions, be given with housing.

Applications on Form AE6/ACT obtainable from the Regional Secretary,

Central Electricity Generating Board,
Southern, South Western and South Wales Region,
1 Eaton Crescent, Clifton, Bristol, 8,

should be returned to him together with any other appropriate information, by not later than Monday, 7th November, 1960.

E6838 A

BRUSH

MECHANICAL ENGINEERS

RESEARCH DIVISION

The Mechanical Department of the Research Division is being expanded and moved into new laboratories. An excellent opportunity therefore exists for well qualified and experienced engineers who are interested in the following fields :

PRODUCTION ENGINEERING RESEARCH— a wide variety of problems associated with new production methods and processes.

HEAT TRANSFER— experimental and theoretical problems connected with both liquid and gaseous coolants in a variety of applications.

VIBRATION AND STRESS ANALYSIS— experimental and computer methods of solution.

BEARINGS AND LUBRICATION— experimental and theoretical problems ranging from conventional systems to extremely high temperature gas bearings.

Senior Engineers are required in all groups, and suitable candidates will be considered for posts as Section Leader.

The Company is situated on the outskirts of a small town amid the pleasant Leicestershire countryside. Loughborough offers many fine schools of all grades and there are facilities for advanced studies at technical colleges and universities in the district. Successful candidates can look forward to an attractive salary and stable employment.

In appropriate cases assistance can be given with housing removal expenses.

Applications, WHICH WILL BE TREATED IN THE STRICTEST CONFIDENCE, should give brief details of experience, qualifications and the field of interest and should be addressed to Mr. P. A. McCaig, quoting reference : PL. 9091.

BRUSH ELECTRICAL ENGINEERING COMPANY LIMITED,
LOUGHBOROUGH, LEICESTERSHIRE.

E6888 A

SITUATIONS VACANT

THE GLACIER METAL CO. LTD.,
WEMBLEY, MIDDLESEX
RESEARCH & DEVELOPMENT ORGANISATION

MACHINE TESTING ENGINEER

required for the testing and development of prototype engineering machine tools. Work involves subjecting prototype machine tools to use tests to ensure that the design conforms to specifications, and to carry on development of the machine as is appropriate off the drawing board. Applicants should have a good knowledge of electrical circuits, hydraulic and pneumatic actuated mechanisms, and be able to carry out these activities in a scientific manner. Occasional visits to our Factory in Scotland may be necessary.

Applicants should be between 25-40 years of age, be in possession of an engineering degree, or H.N.C., and have served a recognised apprenticeship.

38 hour week. Starting salary £950-£1150 per year.

Applications giving full details of educational and industrial experience to :

The Personnel Officer (3093),
The Glacier Metal Co. Ltd.,
Ealing Road, Wembley. Per. 6611.

E6880 A

SITUATIONS VACANT

KENWOOD MANUFACTURING (WOKING) LIMITED

WORKS MANAGER

A Works Manager is required for the Kenwood Group Factory at Woking, engaged on the production of domestic appliances.

An excellent salary plus superannuation will be paid to an experienced executive, who must have previously held a similar position involving practical production experience in the light Engineering field.

The successful applicant will be a man who possesses drive and initiative and who is capable of taking full responsibility for the organisation and planning of the factory to meet production targets. Familiarity with standard costing and budgetary control systems will be an advantage.

Applications, which will be treated in the strictest confidence, must be in writing, setting out full particulars of education, previous experience, age and present salary, and addressed to the Works Director, Kenwood Works, Old Woking, Surrey.

E6876 A

SITUATIONS VACANT

THE GLACIER METAL CO. LTD.,
WEMBLEY, MIDDLESEX
RESEARCH & DEVELOPMENT ORGANISATION

DRAUGHTSMAN

required to work on design of semi-automatic and automatic engineering machine tools and process machinery. The work demands a knowledge of electrical and mechanical engineering, including hydraulic and pneumatic actuated mechanisms, and the ability to produce original ideas.

Applicants should be between 25-40 years of age, be in possession of an engineering degree, or H.N.C., and have served a recognised apprenticeship. 4/5 years' experience of machine tool design or equivalent type of work.

38 hour week. Starting salary £950-£1150 per year.

Applications giving full details of educational and industrial experience to :

The Personnel Officer (3071),
Glacier Metal Co. Ltd.,
Ealing Road, Wembley. Per. 6611.

E6879 A

SITUATIONS WANTED

COMPANY ACCOUNTANT (I.N.C.A.) Office Manager with several years foreign experience—accounting, costing, cashier—general office routine—desires to hear of a suitable vacancy overseas—preferable Middle East or Central or South America. —BOX No. E3039, " The Engineer." H

MAN, 40, adaptable, seeks change to a position where initiative and responsibility are rewarded. Public School, Engineering College. Engineer Officer. Experienced in Buying, Selling, Production Sheet Metal, I.C. engines, General Administration. Salary around £1500.—BOX No. E8670, " The Engineer." H

MISCELLANEOUS

DAVIES INVESTMENTS LIMITED
BANKERS

(Gross assets £2,000,000), are paying 7½ per cent. p.a. interest on deposits for the seventh year in succession, with ½ per cent. added annually on each £500 unit.—Details and Audited Balance Sheet from : Investment Dept. ER.

DAVIES INVESTMENTS LTD.,
DANES INN HOUSE, 265 STRAND,
LONDON, W.C.2.

E178 I

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft or 6ft diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PATENTS

THE PROPRIETOR of British Patents Nos. 711112 and 751139, are entitled : " IMPROVEMENTS RELATING TO THE CONDITIONING OF THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES," and " EXHAUST GAS PURIFIER," offers same for license or otherwise to ensure practical working in Great Britain. —Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn Street, Chicago 3, Illinois, U.S.A. E6807 H

THE PROPRIETOR of British Patent No. 754947, entitled " A DEVICE FOR TRANSPORTING LOADS SUCH AS AUTOMOTIVE VEHICLES OR FREIGHT," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St., Chicago 3, Illinois, U.S.A. E6808 H

THE PROPRIETOR of British Patent No. 753435, entitled " MAGNETIC SEPARATOR FOR USE IN CONNECTION WITH AN ENDLESS CONVEYOR," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St., Chicago 3, Illinois, U.S.A. E6896 H

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throughout the whole of the Engineering Industry

E194 RD

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Telephone : GLAdstone 8020.

E5847 O

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MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.— MOBILE LIFTING SERVICES LTD., A member of the TARMAC Group, Rotherham 78481. E186 K

MACHINERY Etc. WANTED

WANTED FOR CASH all types of Electrical Plant, A.C. & D.C. Motors, Diesel Generating Sets, Transformers, Turbo-Alternators, Cables Dismantling Staff Available.—ELECTRICAL PLANT & MACHINERY Co., 12 Hilton St., E.1. E5893 F

The world's leading inventors and manufacturers of special purpose precision machinery for the Tobacco Industry have opening in their London Drawing Office for :

SENIOR ELECTRICAL DESIGNER

Desirable applicant should be aged 30 to 40, with technical qualifications at least up to H.N.C. level, and with practical experience in the design and application of control circuits for small motors and electro-mechanical detector units. Some knowledge of electronics an advantage.

This opportunity is permanent and progressive ; it offers immediate pensionable staff position with 3 weeks Annual Holiday and attractive commencing terms. Applications stating age, qualifications and experience should be personally addressed in confidence to

G. B. Salmon,
MOLINS MACHINE CO. LTD.,
Evelyn St., London, S.E.8.

E6778 A

CHIEF DESIGNER

Applications are invited for the post of Chief Designer with Bratby & Hinchliffe Ltd., Gorton, Manchester 18, Designers and Builders of Automatic Bottling Machinery, preferably with experience of high speed, intricate, mechanical motions.

This post carries senior staff status, substantial salary and excellent prospects for the right man.

Applications to be addressed to Managing Director.

E6890 A

BRITISH BROADCASTING CORPORATION

MECHANICAL ENGINEER

required to work in a well equipped laboratory in Central London. The post demands considerable originality of thought and initiative in the design and development of all kinds of sound recording and reproducing equipment and also in advising on the mechanical aspects of the design of a wide range of other equipment used in sound and television broadcasting. Experience of, and a high degree of skill in the design of small mechanisms are necessary and some knowledge of audio frequency electronics is very desirable. An acquaintance with sound recording techniques would be an advantage but is not essential. Candidates who must be of British nationality should have a degree or an equivalent professional qualification in mechanical engineering but in the absence of formal qualifications evidence of considerable personal attainment in the design of light machinery would be considered. The salary, commensurate with qualifications and experience, from £1395—£1970 p.a. Application forms from Engineering Recruitment Officer, Broadcasting House, London, W.1., quoting ref : 60.E.146. Eng.

E6841 A

QUALIFIED ENGINEER

aged 25-30, required to assist Factory Manager on technical matters associated with production, and to help implement existing plans for the expansion of this Factory.

Qualifications desired include H.N.C. and experience in production engineering.

Salary according to age and experience ; Staff Life Assurance and Pension Scheme.

Please write for application form, giving age and brief details of qualifications and experience to :

Personnel Manager,
Universal Grinding Wheel Co., Ltd.,
Stafford

E6792 A

MATHER & PLATT LIMITED
PARK WORKS
MANCHESTER

ENGINEERS — PHYSICISTS

The Company has an extensive Research programme of a practical nature ahead concerning the development of new and the improvement of existing machines and methods.

Accordingly, applications are invited for the following permanent appointments :—

TWO SENIOR MECHANICAL ENGINEERS (up to 35 years)
FOUR TECHNICAL ASSISTANTS (MECHANICAL ENGINEERS OR PHYSICISTS up to 28 years)
TWO JUNIOR ELECTRONICS ENGINEERS (up to 25 years)

The Company operates a Non-contributory Pension Scheme with Life Assurance arrangements and working conditions cannot be bettered.

Please address applications to :—

DIRECTOR OF RESEARCH,
MATHER & PLATT LTD.,
PARK WORKS,
MANCHESTER, 10

E6845 A

A. MONK & CO. LTD.,
WARRINGTON, LANCS.

REQUIRE SENIOR and JUNIOR SITE ENGINEERS

Applications invited from those who are experienced in the various duties and responsibilities associated with these positions. Permanent and progressive posts. Superannuation Scheme in operation. Applications in confidence stating age, full details of experience and qualifications etc. to :—

Personnel Manager,
A. Monk and Company, Limited,
Padgate, Warrington, Lancs.

E6722 A

Classified Advts. continued on page 104

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200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.-70ft. extendible jib; 8½-ton Ransome Diesel/Electric 21ft. jib; 6-ton Coles Diesel/Electric, solids; 4-ton Coles Diesel/Electric, solids, 1945; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—25-ton Girders and end carriages, with 60 h.p. motors, 95ft. 10in. span; 30-ton Vaughan, 42ft. 3in. span; 25-ton Clyde, 21ft. 9in. span, new 1954; 20-ton Vaughan, 42ft. 3in. span, 6-ton auxilliary, cab control (5); 20-ton King, 42ft. 3in. span, 400/3/50; 10-ton Heywood, 34ft. span, new 1953, (2); 10-ton Morris, 32ft. 10in. span, 400/3/50; Wharton, 74-ton, 25ft. span, 400/3/50; 5-ton Henderson, 24ft. 7in. span, 1946; 5-ton King, 29ft. 3in. span, power hoist, hand travel; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel; 4-ton Morris, 19ft. span, 220V. d.c. (3); majority of the above are unused.

DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric; 1½-ton Anderson Grice, hand, 40ft. jib; 5-ton Butters Grabbing, 80ft. jib, electric.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Grafton, 34ft. jib, diesel conversion; 8-ton Wilson, steam, 35ft. jib; 5-ton Smith, 50ft. jib (2).

LOCOS.—Fowler diesel, 150 h.p. (2); Barclay & Ruston, 80/88 h.p., diesel; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941; 4 Logan Battery-operated, 24in. gauge, 3-4-ton cap.; 3 Ruston diesel 16/20 h.p., 24in. gauge; also 2 miles 20 lb. and 1200 yds. of 25 lb. x 24in. gauge track, Bogies, Wagons, &c.

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CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s., including 150 by 18ft. lengths, 6in. Stanton class "B" Spigot and Socket, unused. Immediate delivery.

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RHODES Open Fronted Upright Bench Punching Press, motorised for 400/3/50 supply, pressure exerted approx. 2 tons, stroke ¼in., adjustment to table ¾in., table 9in. by 4¾in., hole in table 1in. by 3in., weight approx. 3½ cwt.

PELS Double Geared All Steel Double Ended Angle and Tee Iron Cropping Machine, motorised for 400/3/50 supply, on turntable base for positioning in any direction, crops angles 7in. by 7in. by ¾in. or 6in. by 6in. by ¾in., tees 6½in. by 6½in., on the square and on the bevel, weight approx. 105 cwt.

PELS Double Ended Universal Punching, Shearing & Section Cropping Machine, motorised for 400/440/3/50 supply, punches up to 1¼in. diameter by 1in. thick, depth of punch gap 24in., shears flat bars up to 1in. thick, crops rounds, tees, squares and angles in proportion, weight approx. 8 tons.

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Photographs of the above are available.

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600

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		Main Location	*Auctioneers*
October 28	**Miscellaneous stores.** including :—	Returned Stores Group, **Reed Hall, Colchester, Essex**	**FENN WRIGHT & CO.** (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 73171)
	Tool kits ; weighing and bread slicing machines ; gravity rollers ; wooden pallets ; carpets ; stair carpet and rugs ; furniture ; folding iron beds ; mattresses ; bedding ; 6,500 blankets ; clothing and boots ; butchers, cooking and kitchen utensils ; camp, webbing and fire fighting equipment ; ground sheets ; 40 tons of canvas tent inners ; tent poles ; 270 14ft by 14ft canvas tents ; large mesh netting and other stores lying at Colchester.		
November 1	**Machine tools and miscellaneous stores** including :—	W.D. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON,** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
	Capstan, turret, gap bed, S.S. and S.C., surfacing and boring lathes ; grinders ; horizontal millers ; arbor presses ; Watsonian box sidecars ; tyres and tyre pumps ; hydraulic, screw and trolley jacks ; towing ropes ; M.T. and motorcycle spares ; diesel fuel pumps ; starter motors, dynamos ; Avo test meters ; electrical spares ; storehouse trucks ; hand tools including hammers and axes. Prismatic binoculars ; telescopes ; microscope binocular eyepieces ; centrifugal separator ; gas fired heat treatment furnace ; electric ovens and kiln ; waveform' monitors ; electronic apparatus ; aluminium containers ; Burma teak planks etc.		
November 8-9	**Machine tools and miscellaneous stores.**	W.D. Storage Depot, **Royal Arsenal, Woolwich, London, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL,** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
November 15-16	**Vehicles and miscellaneous stores.**	Central Ordnance Depot, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.,** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
November 24	**Vehicles and miscellaneous stores.**	W.D. Storage Depot, **Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.**	**DIXON & WALLACE, LTD.,** (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
November 29-30	**Vehicles, earth moving equipment, mobile cranes and motor cycles.**	W.D. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
December 13	**Machine tools and miscellaneous stores.**	W.D. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at Cheetham Town Hall, Manchester 8).	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)

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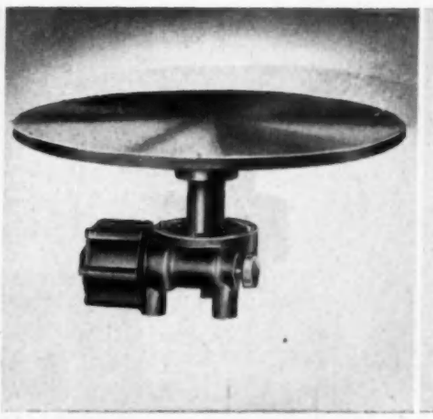

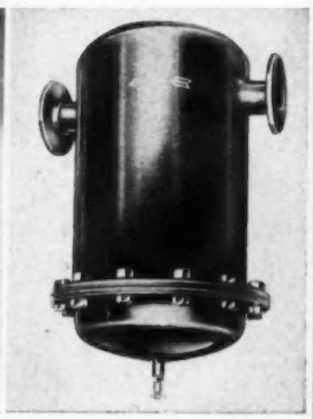

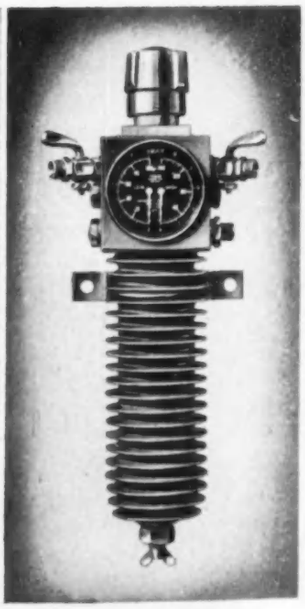

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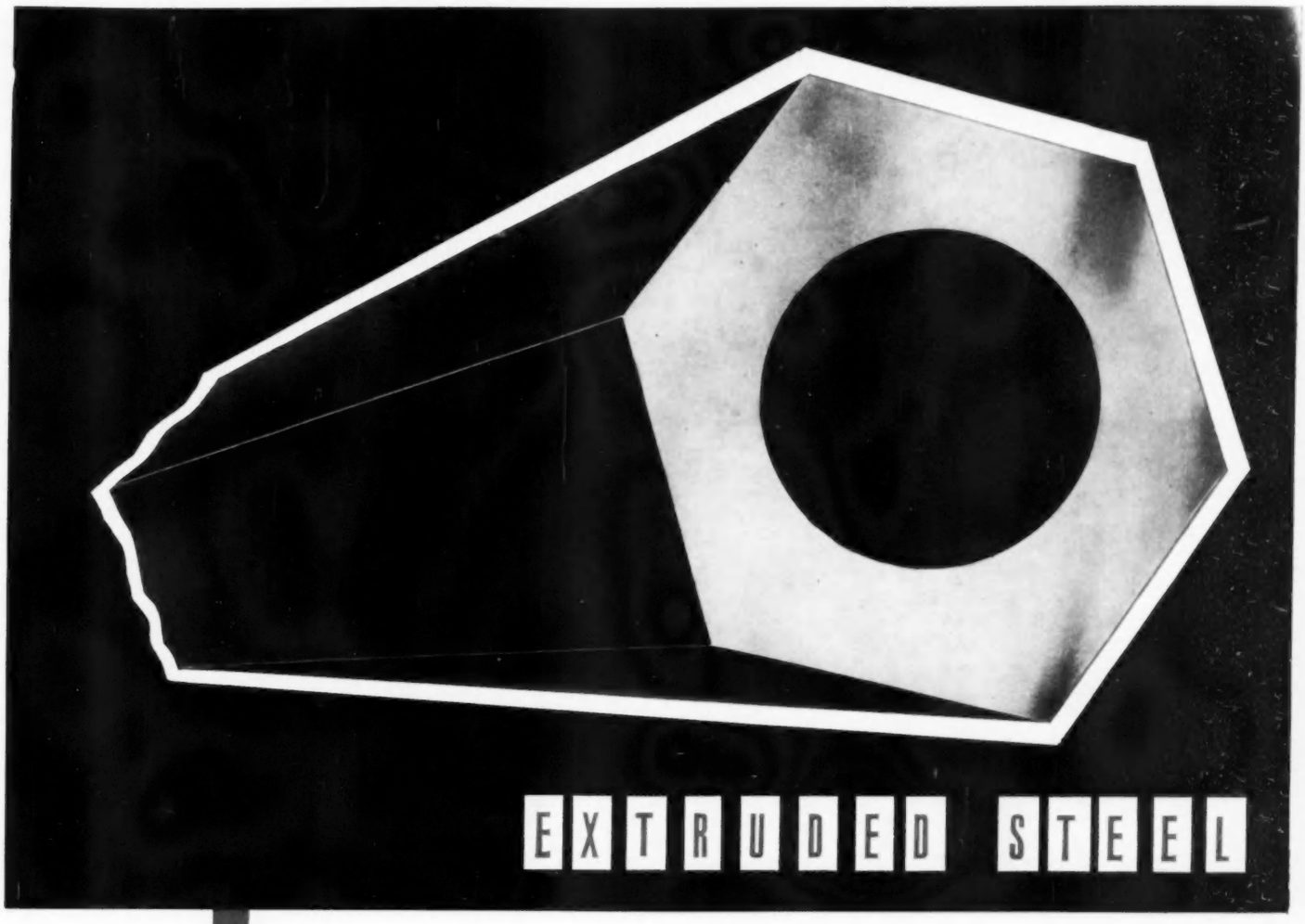

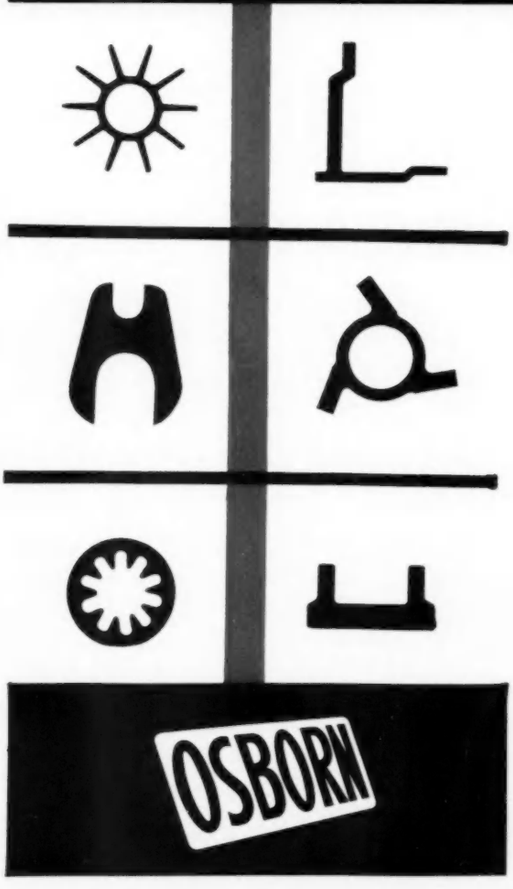

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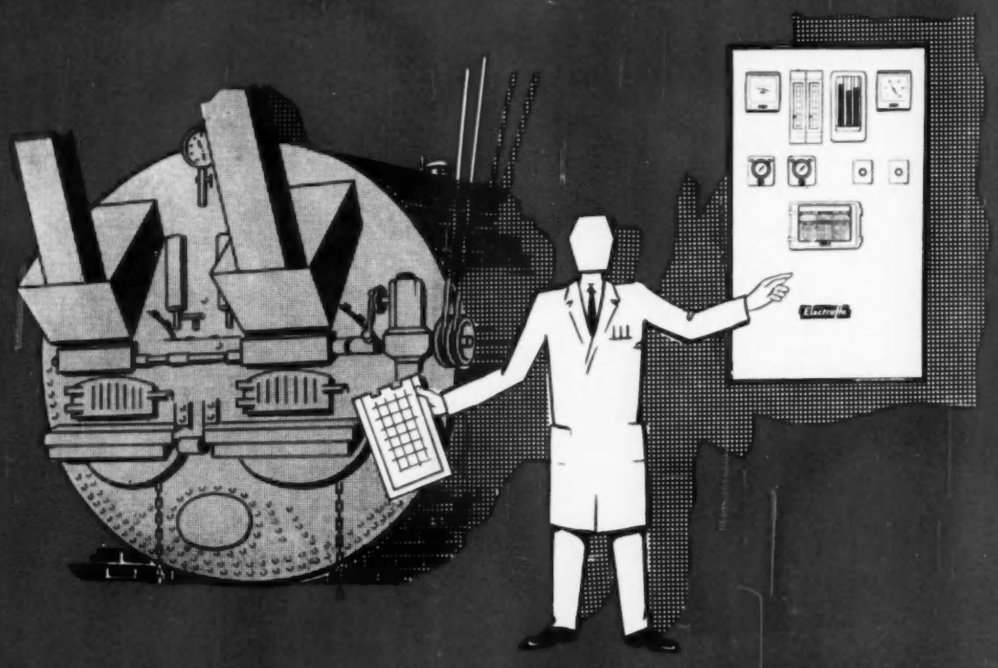

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